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Three Essays on Marriage, Health and Social Stratification in China

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Abstract

China has undergone remarkable socioeconomic and demographic transitions in recent decades. In the wake of these changes, a large body of research has investigated the ways that socioeconomic status shapes family formation, labor market outcomes, and health and wellbeing. While sociological research in China disproportionately focuses on socioeconomic status as an important factor in understanding family formation, labor market outcomes and health disparities, there is little attention to health as an important human capital dimension—one that might matter for labor market outcomes, and might be related to marriage. By utilizing the China Health and Nutrition Survey, a large-scale, longitudinal survey, this study enables investigation of competing hypotheses about linkages among marriage, health and social stratification over the life course. Chapter one of the dissertation addresses how marriage is related to an individual's health over the life course. Chapter 2 investigates a) the association between marital transition and weight change and b) how this association differs by gender. Chapter 3 investigates the association between weight status and labor market opportunities, and how this relationship varies by gender and level of urbanization of communities, given rising concerns about labor market discrimination and imbalanced regional development. Empirical results show that marriage is related to individuals' self-rated health over the life course, but that the relationship varies by gender. Among men, there are no health differences by marital status after accounting for selection bias. Among women, health differences between those who are single and those who are married are trivial, but health benefits of marriage emerge when comparing married and widowed women. Moreover, the health benefits of marriage for women erode over the life course. Married people are also heavier than non-married people, and non-married women lose more weight than their married counterparts. This phenomenon may be due to parental pressures to marry and other attributes of the Chinese context. Furthermore, heavier people--men and women--also face more difficulties in finding a job, and these difficulties are aggravated in highly-urbanized communities. In summary, this dissertation shows that health disparities are closely tied to marriage and to labor market opportunities in China.

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THREE ESSAYS ON MARRIAGE, HEALTH AND SOCIAL STRATIFICATION IN CHINA

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ABSTRACT

THREE ESSAYS ON MARRIAGE, HEALTH AND SOCIAL STRATIFICATION IN CHINA

Li-Chung Hu

Emily Hannum

China has undergone remarkable socioeconomic and demographic transitions in recent decades. In the wake of these changes, a large body of research has investigated the ways that socioeconomic status shapes family formation, labor market outcomes, and health and wellbeing. While sociological research in China disproportionately focuses on socioeconomic status as an important factor in understanding family formation, labor market outcomes and health disparities, there is little attention to health as an important human capital dimension—one that might matter for labor market outcomes, and might be related to marriage. By utilizing the China Health and Nutrition Survey, a large-scale, longitudinal survey, this study enables investigation of competing hypotheses about linkages among marriage, health and social stratification over the life course. Chapter one of the dissertation addresses how marriage is related to an individual's health over the life course. Chapter 2 investigates a) the association between marital transition and weight change and b) how this association differs by gender. Chapter 3 investigates the association between weight status and labor market opportunities, and how this relationship varies by gender and level of urbanization of communities, given rising concerns about labor market discrimination and imbalanced regional development.

Empirical results show that marriage is related to individuals' self-rated health over the life course, but that the relationship varies by gender. Among men, there are no health differences by marital status after accounting for selection bias. Among women, health differences between those who are single and those who are married are trivial, but health benefits of marriage emerge when comparing married and widowed women. Moreover, the health benefits of marriage for women erode over the life course. Married people are also heavier than non-married people, and non-married women lose more weight than their married counterparts. This phenomenon may be due to parental pressures to marry and other attributes of the Chinese context. Furthermore, heavier people--men and women--also face more difficulties in finding a job, and these difficulties are aggravated in highly-urbanized communities. In summary, this dissertation shows that health disparities are closely tied to marriage and to labor market opportunities in China.

TABLE OF CONTENTS

ACKNOWLEDGMENT III

ABSTRACT IV

LIST OF TABLES IX

LIST OF ILLUSTRATIONS X

CHAPTER 1 1

MARITAL STATUS AND SELF-RATED HEALTH IN CHINA: A LONGITUDINAL DATA ANALYSIS 1

1. Introduction 1

2. Theoretical Framework 3

3. China Background 6

3.1 Marriage Markets, Filial Norms and Intergenerational Support in China 6

3.2 Marriage and Health in China 9

4. Data and Methods 11

4.1 Data 11

4.1.1 Outcome Variables 12

4.1.2 Main Explanatory Variables 13

4.1.3 Control Variables 13

4.2 Random- and Fixed- Effects Models 15

5. Results 17

5.1 Descriptive Analyses 17

5.2 Multivariate Analysis 19

5.3 Discussion 25
6. Conclusions 28
7. Tables and Figures 30
9. Bibliography 39
CHAPTER 2 46
GENDER, MARITAL TRANSITIN AND BMI CHANGE IN CHINA 46
1. Introduction 46
2. Theoretical Framework 49
3. China Context 52
3.1 Gender, Union Formation and Social Stigma 52
3.2 Low Divorce and Remarriage Rates 54
4. Data and Methods 55
4.1 Data 55
4.2 Outcome Variables 56
4.3 Explanatory Variables 56
4.4 Control Variables 57
4.5 Analytical Approach 58
5. Results 59
5.1 Whole-sample Analysis 59
5.2 Analysis of Gender Differences 61
6. Conclusions 63
7. Tables and Figures 67
8. Reference 75

CHAPTER 3 82

WEIGHT STATUS AND EMPLOYMENT STATUS IN CHINA 82

1. Introduction 82

2. Weight Status and Labor Market Outcomes 83

3. Mechanisms 85

4. Research Questions 86

5. China Context 86

6. Data and Methods 88

6.1 Dependent Variables 89

6.2 Main Explanatory Variables 89

6.3 Mediator variables 90

6.4 Methods 92

7. Results 92

7.1 Summary and Conclusions 95

8. Tables and Figures 97

9. Bibliography 104

APPENDIX 108

LIST OF TABLES

Table 1: Descriptive Table of All Variables
Table 2: Marital Status by Gender and Age Groups (%)
Table 3: Bivariate Regression Coefficients between Self-rated Health And Marital Status by Gender and Age Groups (Married as Reference)
Table 4: OLS, Random- and Fixed-Effects Estimation of Self-rated Health with Marital Status among Chinese Men Age 15 and Above
Table 5: OLS, Random- and Fixed-Effects Estimation of Self-rated Health with Marital Status among Chinese Women Age 15 and Above
Table 6: OLS, Random- and Fixed-Effects Estimation of Self-rated Health with Three-way Interaction between Gender, Marital Status and Age among Chinese Population Age 15 and Above
Table 7: Summary of Theoretical Perspectives on Marriage-BMI Relationships
Table 8: Descriptive Table of Marital Transition
Table 9: Descriptive Table of all Variables
Table 10: OLS Estimation of BMI (logged) Changes between Time t and t+1 with Marital Transition among Chinese Population
Table 11: OLS Estimation of BMI (logged) Changes between Time t and t+1with Interaction between Gender and Marital Transition
Table 12: OLS Estimation of BMI (logged) Changes between Time t and t+1with Interaction between Gender and Marital Transition
Table 13: Description of All variables
Table 14: Distribution of Weight status by Gender (%), CHNS 1991-2009
Table 15: Odds Ratios from Bivariate Binary Logistic Regression of Being Employed on Independent Variables by Gender
Table 16: Random- and Fixed- Effects Logistic Regressions of Being Employed with BMI and Interaction between BMI and Urbanization among Chinese Men aged 18 and above
Table 17: Random- and Fixed- Effects for Logistic Regression of Being Employed with BMI and Interaction between BMI and Urbanization among Chinese Women aged 18 and above

LIST OF ILLUSTRATIONS

Figure 1: Distribution of Self-rated Health over Age by Gender in 1991
Figure 2: Predicted Self-rated Health Differences by Gender and Marital Status over Age
Figure 3: Distribution of Weight Status over Survey Year by Gender

CHAPTER 1

MARITAL STATUS AND SELF-RATED HEALTH IN CHINA: A LONGITUDINAL DATA ANALYSIS

1. Introduction

The health implications of marriage have been widely documented in many national settings, as family is a major source of social support that may enhance adults' health and wellbeing (House, Landis, & Umberson, 1988a; Kiecolt-Glaser & Newton, 2001; Lillard & Panis, 1996; Riley, 1994). While much research investigates the association between marriage and health, most of the work has focused on developed countries. There is less evidence about the marriage-health linkages in low and middle income countries, where marriage markets, family dynamics, and social norms may differ substantially from those characterizing developed countries.

For instance, China has distinctive marriage market features and strong filial norms related to extended family and intergenerational supports (Bian, Logan, & Bian, 1998; Cong & Silverstein, 2012; Gupta, Ebenstein, & Sharygin, 2010). Marriage markets in China are well-known for highly skewed sex-ratios, resulting from strong son preference and the execution of the one-child policy (Gupta et al., 2003; Zhu, Lu, Hesketh, & others, 2009). As a result, men in lower socioeconomic statuses have difficulties in finding spouses (Gupta et al., 2010). Another emerging phenomenon in marriage markets in China is a marriage mismatch for educated women. Unmarried women in their late 20s are stigmatized as "leftover ladies" (Qian & Qian, 2014). The health consequences of being unmarried for men and women have become pressing issues as the phenomenon of delayed marriage or non-marriage has become more pervasive (Fincher, 2014; Zhou, Wang, Li, & Hesketh, 2011). Furthermore, strong filial norms related to extended family and intergenerational support remain persistent and pervasive in China, despite the rapid socioeconomic change in recent decades (Chen & Liu, 2012; Lin & Yi, 2011; Zhenglian, 2004). Extended family and intergenerational support are other forms of social relationships, which also provide emotional and financial supports if people face stressful events in their life.

Given the different context of marriage markets, family structures and social norms in China, the marriage-health relationship may differ from that found in Western countries. In this paper, I draw on a unique longitudinal dataset from nine provinces in China to assess the link between marriage and overall health status, as proxied by self-rate health. I address the following questions: What is the link between health and marriage in China? How does the marriage-health link vary by gender and age? And, does the observed marriage-health relationship persist after correcting for omitted variable bias?

This research contributes to existing literature in three ways. First, the dearth of large-scale longitudinal data limits our knowledge of the marriage-health gradient. By utilizing large-scale, population-level, longitudinal data, this study enables simultaneous examination of various theoretical frameworks with causal evidence, adding solid empirical evidence to this research field. Second, China presents a special case with distinctive marriage markets and social norms. Using China as a case study enables this paper to extend and test theoretical frameworks developed in Western countries in a very different context, and thus to contribute to a comparative literature about whether the marriage-health gradient is uniform in different social contexts. Third, this study complements existing social science work on marriage markets in China, which has focused on the shortage of marriageable women for men, mismatch in the marriage market, and the stigma against single women, by investigating the unexplored health implications of marital entrance and exit.

2. Theoretical Framework

Social relationships are essential elements of wellbeing. Numerous scholars have addressed questions of how and why social relationships matter for wellbeing (House, Landis, & Umberson, 1988b; Umberson & Montez, 2010). Marriage, as a core component of social relationships and a center of life for many adults, is crucial to wellbeing for adults. A large body of research has suggested the beneficial association of marriage with health outcomes (Ross, Mirowsky, Goldsteen, & others, 1990; Schoenborn, 2004). Married people live longer, on average, and have fewer physical and mental health problems (Lillard & Panis, 1996; Williams & Umberson, 2004; Wilson & Oswald, 2005)

Three perspectives are prominent among proposed explanations for the link between marriage and health: marital protection, marital selection and life course perspectives. The marital protection hypothesis suggests that marriage confers real benefits on individuals' health through several channels. Empirical evidence has found that married people receive more social support and financial resources, compared to their non-married counterparts (House et al., 1988b; Lillard & Panis, 1996). Married people are also less likely than non-married people to resort to substance abuse (Duncan, Wilkerson, & England, 2006) and are more likely to maintain a healthy lifestyle and behaviors (Umberson, 1987). Alternatively, the marital selection hypothesis emphasizes that the effects of marriage on health are primarily due to selection effects. Specifically, healthier people are more likely to be selected into marriage and to remain married than their unhealthier counterparts. Therefore, the correlation between marriage and health is overstated or spurious.

The central debate between marital protection and selection perspectives is whether there is causal relationship between marriage and health. Apart from this debate, scholars also pay much attention on the heterogeneous effects of marriage on health (Carr & Springer, 2010).Life course perspectives provide a comprehensive framework to explain heterogeneous effects of marriage on health over the course of adulthood. This perspective highlights the importance of timing of social role transition and how social roles are embedded in concrete social contexts and mobilize resource to shape health wellbeing (Elder Jr., 1985; Williams & Umberson, 2004).

Entering or exiting marriage is a salient social role transition over the course of adulthood in a society, and this transition is related to the availability of resources to maintain or improve health and wellbeing. Deviating from expected social roles potentially triggers social stress and constrains resource mobilization. Therefore, the life course perspective predicts that benefits of marriage for individuals vary across life stages, as marriage is an age-graded life transition. The health gain in transition into marriage is likely to be larger at older ages than at younger ages, since being married is considered to be a normative social role transition, and getting married is likely to relieve social stress and may promote access to emotional resources provided within intimate relationships. At older life stages, family may be more central to social life, and is also the major source of social support, whether emotional or instrumental. Thus, transition out of marriage at older life stages may have a stronger detrimental effect on health than earlier life stage.

The possibility of gender differences in the relationship between marriage and health is another salient dimension that remains open to empirical investigation (Carr & Springer, 2010; Williams, 2003). Men and women tend to play different social roles within and outside families. Women are more likely to be caregivers and monitor the unhealthy behaviors of men, and women may be better connected with other people than men (Williams & Umberson, 2004). For these reasons, men may gain more health benefits than women from staying in marriage and are more vulnerable when they exit marriage. Nonetheless, empirical findings about the gender differences in health benefits of marriage are inconsistent. Williams & Umberson (2004) show that men, but not women, have worse self-rated health after exiting marriage. Elwert & Christakis (2006), however, found that both white men and women suffer substantial widowhood effects and there is no appreciable gender difference in widowhood effects.

Additionally, the role of marriage in shaping health also depends on whether other forms of social relationships provide similar functions (Elwert & Christakis, 2006; Sarkisian & Gerstel, 2008). Elwert & Christakis (2006) show that loss of a spouse increases the risk of mortality for both white men and women, but there were no substantial widowhood effects for African Americans. The authors argue that higher frequency of church attendance or receiving more social support from family and kinship networks—inside or outside of households—than White counterparts mediates the detrimental effects of loss of spouse among Africa Americans. This evidence suggests that the health implications of marriage may vary according to prevailing norms about filial or familial responsibility and cultural traditions.

In sum, evidence suggests that the relationship between marriage and health is not uniform across gender and age, due to different social roles for men and women and different contexts at each life stage. Evidence also suggests that marriage effects may also differ depending on prevailing social contexts and norms about family and filial responsibilities, as marriage is an import, but not sole, source of social support that enhances wellbeing.

3. China Background

3.1 Marriage Markets, Filial Norms and Intergenerational Support in China

A great deal of research has investigated features of marriage markets and filial norms related to intergenerational support in China (Riley, 1994; Slote & De Vos, 1998), but the marriage health relationship remains unexplored. The theoretical frameworks and empirical evidence discussed above are relevant for developing hypotheses about the marriage-health relationships in China. However, the nature of the marriage-health relationship, as well as when and for whom marriage matters for health, are not completely straightforward for the case of China, due to some distinctive features of Chinese marriage markets and the broader Chinese social context. These features make China's marriage market an interesting case to test theoretical frameworks developed in Western countries.

One distinctive feature of the marriage market is that it is distorted by an abnormally high male-female ratio in China, resulting from strong son preference in combination with the implementation of the one-policy in the last couple of decades.(Banister, 2004; Ebenstein & Sharygin, 2009). Consequently, many men will be lifelong bachelors and men with better socioeconomic standing are considerably more likely to find a spouse than disadvantaged men (Gupta et al., 2010).

A second distinct feature is a rapid trend toward delaying marriage for men and women. The expansion of education, rapid industrialization after market transition, and the pursuit of personal careers all contribute to this on going phenomenon (Mu & Xie, 2014; Oppenheimer, 1988).However, social attitudes and expectations toward late marriage differ for men and women. High bride price for men, along with expectations that they will be breadwinners after marriage, means that men may delay marriage in order to accumulate economic resources (Jiang & Sánchez-Barricarte, 2012; Wei & Zhang, 2009).This delay is socially tolerated, especially since men may marry younger women. Recent research indicates that marital age hypergamy has been increasing since the post-1990s reform era, because of increasing economic pressures and the rise of gender inequality labor markets in China (Mu & Xie, 2014).

By contrast, traditional gender roles and stereotypes remain unchanged, even though women are more educated and economically independent than before. Thus, women face pressure from parents and other relatives if they delay marriage, and unmarried women are explicitly and implicitly stigmatized in various social settings (Fincher, 2014; Qian & Qian, 2014). Media campaigns even portray women who remain single in their late 20s as “leftover” women (Fincher, 2012). This hostile social environment may trigger stress among single women. Overall, the health consequences of the skewed sex-ratio in marriage markets for unmarried men and of the conservative and hostile attitude toward unmarried women have emerged as a pressing issue in China (Dyson, 2012; Fincher, 2014; Zhou et al., 2011).

A third distinctive feature of family life in China is a strong filial norm of intergenerational support. Traditionally, children are obligated to take care of their aging parents. Parents, in turn, are often expected to engage in the raising of their grandchildren. As a consequence, the prevalence of co-residence is high relative to that found in the U.S. Co-residence with children is associated with better psychosocial wellbeing in China (Wang, Chen, & Han, 2014). Even if adult children don't live with their aging parents, they often live close to parents, maintain frequent contact with them and provide regular help to them (Bian et al., 1998; Chen & Liu, 2012). By contrast, empirical evidence in the U.S. shows that marriage potentially undermines relationships with parents. Compared to unmarried adult children, married adult children less frequently stay in touch with parents or provide or receive practical help (Sarkisian & Gerstel, 2008).

Despite researchers' having anticipated that filial norms are going to diminish steadily along with socioeconomic development and the establishment of institutional social support systems, recent evidence has shown that intergenerational support related to filial norms is persistent and pervasive in China (Chen & Liu, 2012; Lin & Yi, 2011). Beyond an instrumental sense of social support in the Chinese extended family system, emotional intimacy is distinguished in the Chinese extended family system from many other countries, too. The family system in China does not merely have a different structure and composition compared to many other countries; it also establishes strong affectional ties among family members. A cross-national comparison study from 16 countries shows that respondents in almost every country report emotional intimacy with their parents and siblings, but not with other extended family members. However, Chinese respondents also express emotional closeness to their kin members, such as grandparents, uncles and aunts, and cousins (Georgas et al., 2001). This strong connection with extended family members implies the presence of larger, kin-based social support networks who are available to help when individuals face difficulties in life.

A strong norm of intergenerational support also has implications for how the marriage-health relationship may vary across life stages and by gender. As mentioned earlier, Chinese elderly rely heavily on support from their adult children and are responsible for taking care of their grandchildren. Those divorced or widowed at older ages may experience less harm than those divorced at younger ages, because children are more mature and have more capacity and resources to provide supports. At the same time, taking care of small grandchildren, an obligation which falls particularly heavily on elderly Chinese women, may be also a burden to the elderly and harmful to their health (Chen & Liu, 2012). However, as grandchildren grow up, grandmothers' burden can be relieved and they may even enjoy support from their grandchildren. By and large, these findings suggest that social support rooted in extended family and filial norms, either in financial, instrumental or emotional forms, continues to be strong and is likely to be a buffer for the stress triggered by exiting marriage, while the benefits of marriage may vary across by age and gender.

3.2 Marriage and Health in China

Marriage-health relationships in China haven't received as much scholarly attention as they have in many developed countries. Existing research has revealed inconsistent findings regarding the role of marriage in shaping health. Gupta et al. (2010) examine the association between self-rated health and marital status using cross-sectional data. The authors found that married men, on average, reported better health than their unmarried counterparts, but they were unable to disentangle selection or protection effects of marriage. Zhu and Gu (2010) compared the risk of mortality between the married and widowed oldest-old Chinese populations using longitudinal data, and found that widowed men have higher mortality rates than their married counterparts, controlling for socioeconomic status, health behaviors and prior health conditions, suggesting protective effects of marriage on mortality among men.

On the other hand, certain evidence suggests that there is no marital protective effect. Zhang (2010) examines the association between marriage and suicide among rural young Chinese women between age 15 to 34 with a case control design. Despite the fact that marriage is considered to be a relevant protective factor in the U.S., the author found that there is no marital protection against suicide. Other research shows that there is no association between marriage and self-rated health, although marriage is not the main research focus (Chen, Yang, & Liu, 2010).

In sum, existing literature regarding the marriage-health relationship is limited in two ways. First, analyses using cross-sectional data are not able to correct for omitted variable bias, and thus may have biased estimation of marital protective effects. Second, only certain age groups or causes of death are included in their analysis. Thus, we are not able to know how and to whom marriage matters for overall health of general Chinese population. I address the first limitation by using large scale population data with application of random- and fixed-effects models. I address the second limitation by using self-rated health to proxy overall health and by incorporating life course perspectives to examine how marriage is related to self-rated health across gender and age.

4. Data and Methods

4.1 Data

Data are from the China Health and Nutritional Survey (CHNS). The CHNS is a multistage probability sample survey of the Chinese population. This survey includes every member living in the same household. The survey has collected data since 1989 in nine provinces of China[1], with follow-up data collection in 1991, 1993, 1997, 2000, 2004 and 2006. I limit my analysis respondents to age 15 and above. In addition, only the 1991 to 2006 questionnaires collected data on self-rated health. Therefore, the sample is further limited to survey rounds from 1991 to 2006. Additionally, the sample is limited to person-time observations without missing values of self-rated health and marital status and about 17% of person-time observations are excluded. Missing values for all other time-varying independent variables are handled with multiple imputation by chain-equation (Rubin, 2004). Following Allison's (2001) instructions for multiple imputation for longitudinal data, each variable with missing values is imputed based on information from all 6 time points and about 6% of person-time observations are imputed. The attrition rate is about 6% to10% across each wave. Because the attrition rate is not low, I also conduct attrition analysis to test whether statistical estimation is biased in this study (See Appendix A and B). The attrition analysis suggests that estimation is unbiased and this result is consistent with many previous findings that sample attrition is not always a concern in longitudinal data analysis (Alderman, Behrman, Kohler, Maluccio, & Watkins, 2001; Falaris & Peters, 1998; Twisk & de Vente, 2002). The final analytical sample is 53404 person-times observations and 17378 cases.

[1] The sample began with eight provinces in 1989 and added a ninth province, Heilongjiang, in 1997.

4.1.1 Outcome Variables

Self-rated health. Self-rated health is measured by the following question: “Right now, how would you describe your health compared to that of other people your age?” Respondents rated their own health from 1 (poor) to 4 (excellent). Self-rated health has the desirable properties that it is a well-established predictor of mortality (Idler & Benyamini, 1997) and also that it is a widely-adopted instrument for overall health status in large scale surveys.

Despite these desirable properties, scholars have also expressed concern that self-rated health, as a subjective measurement of overall health status, is subject to reporting heterogeneity bias, meaning that each individual may report their health status differently, given the same objective health state. Indeed, research in developed countries has found that there is report heterogeneity in self-reported health related to gender and sex, but there is no heterogeneity reporting bias related to socioeconomic status (Van Doorslaer & Gerdtham, 2003). Research from China, Indonesia and India has also yielded a similar conclusion that there is only a slight reporting heterogeneity bias related to socioeconomic status, and thus self-rated health is a valid measurement, reflecting health disparities across demographic and socioeconomic groups (Bago d’Uva, Van Doorslaer, Lindeboom, & O’Donnell, 2008).

Figure 1 displays the distribution of self-rated health over age by gender in the first wave of the survey. Both men and women have a similar distribution of self-rated health over age. As expected, there is a much higher proportion of respondents who report good or excellent health at earlier ages than at older ages. Although the respondents are asked to evaluate their own health compared to people of similar age, we still see variation of self-rated over age for both men and women.

Self-rated health is measured in a four point Likert scale in the original questionnaire. Some scholars suggest that self-rated health should be recoded into a dichotomous variable, but there is evidence to suggest that there is no one superior way than others regarding how to treat self-rated health (Manor, Matthews, & Power, 2000). Self-rated health in continuous form is also a good predictor of risk factors and indicators of illness (Manderbacka, Lahelma, & Martikainen, 1998). Here, self-rated health is treated as a continuous variable in all analysis.

[Figure 1 is about here]

4.1.2 Main Explanatory Variables

Marital status. In the original questionnaires, marital status contains five categories: never married, married, divorced, separated and widowed. However, marital status is relatively stable in China, so that the proportion divorced and separated are small. For this reason, I combined divorced and separated into one category: “divorced”. In all analyses, four categories, namely “single”, “married”, “divorced” and “widowed”, are included. “Married” is the reference group for all models.

4.1.3 Control Variables

There are time-invariant and time-varying variables in my analysis. Time-invariant variables include *female, highest education attained, stature and province*. Female is coded as 1 and male as 0 There are 3 categories of highest education: Lower middle school and below (0), upper middle school (1) and college and above (2). *Anthropometric stature* is included to proxy for health status prior to marriage. Much research has shown that stature is a good proxy for overall long-term nutritional status as well as for early life conditions (Behrman, 2009; Case & Paxson, 2009). The unit of measurement for stature is centimeters and stature is fixed at the highest stature for individual observed across wave in order to avoid the shrinkage of height as the respondent ages. I also include province dummies to control for provincial variation in the level of socioeconomic development.

Time-varying variables include *age, age squared, employment status, per capita household income* and *urbanization*. Age is centered to the lowest age—15—in the analytical sample[2]. Employment status is coded as 1 if the individual is employed and 0 otherwise; per capita household income is defined as the total household income divided by number of household members and used as a proxy for overall household financial resources. All waves of per capita household income are inflated to 2009 and transformed to log form. *Urbanization* is measured at the community level. Instead of using a crude classification of urbanization as rural versus urban, I use an index of urbanicity constructed based on multi-dimensional characteristics of communities, including population, occupation structures, level of education, economic development, infrastructures, health facilities and so on (for details, see Jones-Smith & Popkin, 2010). With this index, the level of urbanization of a community can be better captured than using a crude dichotomous variable indicating rural or urban.

[2]I also tested the results with sample above legal marriage age in China. Results are similar regardless of which sample I used.

4.2 Random- and Fixed- Effects Models

One primary goal of this study is to evaluate the effects of marital status on self-rated health. First, I estimate models in which I treat the data as a pooled cross-sectional design—as if each observation for each wave is a different case—using OLS regression with adjustment for individual clustering. By replicating prior research with this cross-sectional design, I can see the generic pattern of marriage-health association and compare results to other research. Additionally, I estimate separately for male and female subsamples and add an interaction term between age and marital status to investigate gender differences in the relationship between marital status and self-rated health as well as how the relationship changes over age.

Although the analysis has incorporated many confounders, given the nature of observational studies, it is not possible to take into account all potential confounders. The second step of my analysis is to estimate both individual random- and fixed-effects models to address omitted variable bias. Consider the following model, where the subscript i denotes persons and t represents survey waves. Y_{it} refers to self-rated health for individual i observed at time t; x_{it} denotes observed time-invariant covariates and z_{it} refers to observed time-varying covariates α_i represents time-invariant unobserved heterogeneity and ε_{it} refers to residuals.

$$Y_{it} = \beta_0 + \beta x_{it} + \gamma z_{it} + \alpha_i + \varepsilon_{it}$$

In the random effects models, α_i is treated as a random variable and is assumed uncorrelated with independent variables. With this assumption, random effects models allow researchers to estimate coefficients of covariates that both vary within and between persons. In contrast, fixed effects models treat α_i as an individual-specific constant effect that is cancelled from models. Fixed effects models only allow researchers to estimate coefficients of time-varying variables γ and coefficients of time-invariant variables β are conditioned out of models.

Fixed-effects models are of strategic importance to this study and area commonly-used approach to disentangle marital protection and selection (Wilson & Osward, 2005; Wu & Hart, 2002). The advantage of this approach is to allow me to control for time-invariant unobserved heterogeneity. Much research has suggested that personality, which is not commonly measured in a large scale surveys, is one important omitted variable that is likely to be associated with better health and with better chances of getting marriage or staying in marriage (Botwin, Buss, & Shackelford, 1997; Harker & Keltner, 2001).Therefore, the positive association between marriage and health in OLS estimation may the result of positive personality; personality is also likely to associated with different strategies of coping stressful life events (Bolger, 1990; Carver & Connor-Smith, 2010; Holahan & Moos, 1985). Thus, without properly controlling for unobserved heterogeneity, results may overstate the health benefits of marriage.

There are two reasons that my estimation with fixed-effects models is likely to be conservative. As mentioned earlier, there is measurement error due to reporting heterogeneity for self-rated health. By focusing on within-person variations, fixed-effects model may exacerbate measurement error, thus reducing the likelihood of finding statistical significance (Griliches, 1979). Second, the sample size for different marital statuses is relatively small. Focusing on within-person variation thereby may reduce statistical power.

5. Results

5.1 Descriptive Analyses

Table 1 displays descriptive statistics for all variables included in the analysis by gender. Men, on average, have better self-rated health than women. About 10% of men and 7% of women are single in the sample. The prevalence of divorce is about 1% for both men and women, suggesting relatively stable marriage patterns in China. The proportion widowed is substantially different between men and women. The proportion widowed among Chinese women is about three times higher than among men, reflecting the fact that women have a longer life expectancy in China.

[Table 1 about here]

The distribution of marital statuses by gender and age group is displayed in Table 2. This table shows clear marriage patterns by gender over age in China. About 82.6% of men and 66.3% of women are single at ages 15 to 24. The proportion single further rapidly drops to 23.3 % for men and 10.3% for women at ages 25 to 29. By ages 30-34, only about 5% of men are single and less than 2% of women remain single. After age 35, almost all are married. Additionally, the proportion experiencing widowhood increases with age. About 2.14% of men are widowed at ages 45 to 54, and this figure rapidly rises to 5.12% at ages 55 to 64. For women, the proportion widowed is about 5.04% at age 45-54 and almost three times higher at ages 55-64 than at ages 45-54. The proportion widowed further increases to 25.5% for men and 70.6% for women at ages 75 and above. Overall, we can see two clear gender and age patterns regarding marital status. First, getting married is still a normative social role transition. Most Chinese men and women complete this social role transition before age 29 and only a small proportion of people remain single until ages 35 and after. Second, there are trivial differences in the prevalence of widowhood between men and women at the earlier life stages, but the differences rapidly grow over age. This is consistent with the gender pattern in other countries, which shows that women outlive their spouses.

[Table 2 about here]

Table 3 presents estimates of the bivariate association between marital status and self-rated health by gender and age groups. The upper panel shows the relationships between marital status and self-rated health across different age groups of men. As is evident in the upper panel, the relationships are not uniform across age groups. There are no statistically significant differences in self-rated health between single men and their married counterparts before age 29.However, the differences emerge from ages 30 to 54. Although we expect that widowed men have worse health than their married counterparts, counterintuitively, there is no evidence suggesting the existence of differences in self-rated health between married and widowed men. We also see a similar gender and age pattern for women, as shown in the lower panel of Table 3. The health differences between single and married surface between ages 30 to 44 and only those widowed between ages 45-54 show worse health than their married counterparts.

5.2 Multivariate Analysis

In the bivariate analysis, we see that the relationships between marital status and age groups vary across different life stages, but there are many confounders that need to be taken into consideration in order to establish clear marriage-health relationships by gender and over the course of adulthood. Table 4 tests the marriage-health relationships over the life course among Chinese men with OLS, random- and fixed-effects models. In Model (1), single men reported worse health self-rated health than married men ($p<0.01$), net of demographic characteristics, socioeconomic conditions, family resources and urbanization with the application of OLS regression This finding is consistent with prior research in China that being single is related to poor self-rated health among men (Gupta, Ebenstein, and Sharygin, 2010). However, there is no evidence to support that being divorced is associated with poorer heath relative to married among Chinese. Although there is little evidence about the association between divorce and health outcomes in China, evidence from other countries suggests that divorced men generally have worse health than married men (Williams & Umberson, 2004). Counterintuitively, there is no evidence to support that being widowed is associated with poorer health.

Whether the marriage-health relationship varies across life stages is examined with an interaction term between marital status and age. Despite the life course perspective prediction that the marriage-health relationship varies across life stages, the evidence from model (2) doesn't support the prediction. There is only a weak positive relationship in the interaction between being widowed and age. Model (3) tests the same research question as model (1) with a random effects model. Model (3) shows similar results as model (1), suggesting that being single is associated with poorer health than being married among Chinese men. However, the coefficient of being single is only significant at $p<0.1$ in model (3).

Model (5) and (6) replicate the specifications of model (3) and model (4) with a fixed-effects specification. I examine whether the patterns in model (3) and (4) persist after accounting for unobserved heterogeneity. Surprisingly, the coefficient of being single changes from negative to positive. By focusing on with-person variations, fixed-effects models are able to focus on how changes in marital status affect self-rated health within persons across time, at the cost of ignoring all between-person variations. The contrasting sign of the coefficient for single between model (3) and model (5) suggests that between-person variations are large and being single is associated with poor self-rated health. Thus, we see a negative sign in model (3), but a positive sign in model (5), as random effects models are results of a matrix-average weight of between- and within-person variations. In models (4) and (6), the interaction terms between marital status and age are not statistically significant. Thus, there is also no evidence supporting the idea that marriage-health relationships vary across life stages. Moreover, health differences between widows and married men are also negligible. Existing literature from the U.S. suggests that being widowed is associated with poorer health among men; nonetheless, evidence from this study shows that there is no difference between married and widowed men. There are two possible explanations for no appreciable health differences between widowed and married men. First, there might be mortality selection, in which healthier men are more likely to live longer than their spouses as well as survive through the loss of spouse. Alternatively, those widowed men may have recovered from the loss of a spouse; thus, we don't see detrimental effects of being widowed on self-rated health.

Overall, results from OLS and random-effects models support the hypothesis that being single is associated with poorer self-rated health, however, the negative relationship turns positive with a fixed-effects model, showing that being single is healthier than being married among Chinese men. One possible explanation is that single men may already be in stable relationships before marriage, and thus may enjoy similar benefits of marriage. Relatedly, marital quality may decrease over age, and thus we see that married men have worse health than their single counterparts as marital quality is strongly correlated with health status within marriage (Umberson, Williams, Powers, Liu, & Needham, 2006).

An estimation of marital status and self-rated health among women is displayed in Table 5. As can be seen in model (1), single women reported worse health than married women, but the same is not true for divorced/separated and widowed women. This pattern is similar to men's pattern. The marriage-health gradient is, then, tested in model (2). Interestingly, an interaction term between being widowed and age is positive, indicating that being widowed at an earlier life stage worsens self-rated health more than at later life stages. This result supports the prediction of life course perspectives. Model (3) and model (4) test the marriage-health gradient and whether it varies over the course of adulthood with random effects models. As can be seen in model (3), singlehood is associated with a 0.073 points reduction in self-rated health compared to married counterparts and is significant at $p<0.01$. The interaction term between being widowed and age remains significant at $p<0.01$ in model (4), implying the marriage-gradient changes across life stages. Fixed-effects models are applied in model (5) and model (6) to examine whether the observed patterns persist after taking into account omitted variable bias. The coefficient of singlehood changes from -0.073 in model (3) to -0.002 in model (5) and is no longer statistically significant. The disappearance of negative relationship between singlehood and self-rated health suggests that omitted variables that are not included in the models, e.g. personality, explain the negative relationship between singlehood and self-rated health.

The interaction term between widowhood and age is still significant at $p<0.001$, even after taking into account selection bias, as displayed in model (6). The interaction term between widowhood and age shows that being widowed at younger ages is unhealthier than being widowed at older ages. The result supports the prediction of life course perspectives on the variability of the marriage-health gradient over the course of adulthood.

In sum, results from Table 5 support that singlehood is associated with worse health relative to being married among Chinese women. This result might be contributed to by traditional gender norms triggering stress among unmarried women. However, evidence from fixed-effects models suggests that health differences between the single and married are unlikely to be causal effects of marriage on health. In light of health differences between the married and non-married over the life course, evidence shows that widowhood at earlier life stages is related to poorer self-rated health, compared to widowhood at older life stages. This pattern remains persistent after taking into account omitted variable bias. and is consistent with life course expectations that the marriage-health gradient depends on life stages. This observed pattern may be explained by strong filial norms related to intergenerational support: aging parents are mainly supported by their children. Presumably, their children have better capacity and more resources to support their aging parents when they are more mature. Moreover, taking care of grandchildren creates a burden for the elderly and is likely to be related with worse health outcomes (Chen & Liu, 2012). The aging of grandchildren relieves this burden for the elderly.

I examined the marriage-health relationships over age with men and women separately. Here, I conducted a three-way interaction among gender, marital status and age with OLS, random- and fixed- effects models to examine how these three factors jointly determine health differences among Chinese population.

[Table 6 is about here]

An estimation of a three-way interaction among gender, marital status, and age is displayed in Table 6. First, we see that women, on average, report worse health and this relationship is consistent across OLS and random-effects models. This is consistent with prior findings that women have worse self-rated health in other contexts (Case & Paxson, 2005). Singlehood is also associated with poor self-rated health in OLS and random-effects models, as we see in Table 4 and 5. Again, this negative relationship between self-rated health disappears in fixed-effects models, suggesting that omitted variable bias explains this negative relationship. With regard to divorce, divorce is associated with a 0.074and 0.058 points reduction in self-rated health in OLS and random-effects estimations, respectively. The coefficients of divorce are not statistically significant in Table 4 and 5, possibly because there are too few cases of divorce in the analysis of men and women separately. However, this relationship is not persistent after taking into account omitted variable bias, implying that those who are unhealthier are more likely to divorce than their married counterparts. I also find no evidence for gender differences in health regarding the relationship between divorce and self-rated health, while there is a health difference among widowed men and women ($p<0.05$). Widowed men, on average, have 0.52 points better in self-rated health in fixed-effects models (model 6). Additionally, interaction terms of gender, widowhood and age are statistically significant at $p<0.05$ in model (4) and (6). The coefficients of interaction terms are 0.006 and 0.009 in model (4) and model (6), suggesting that there are gender- and marital- differences in health and these differences change over life stages. In order to describe the features of this three-way interaction, a linear prediction based on model (5) is depicted in Figure 2.

[Figure 2 is about here]

First, we clear see that there are gender differences in self-rated health. Men are healthier than women regardless of marital status. However, health differences are constant among married men and women over age, while health differences change over life stages between widowed men and women. Widowed men display better health than widowed women, while empirical evidence from the U.S. shows that widowed men report worse self-rated health than widowed women (Williams & Umberson, 2004). Furthermore, these differences are larger at earlier life stages and converge at older life stages. Second, health differences between widowed and married among women converge over age, but the differences are constant among men.

5.3 Discussion

In this section, I discuss three main findings that emerge from this study: First, being single is associated with poorer self-rated health than being married for both men and women, but the negative relationship disappears after taking into account omitted variable bias. Second, being widowed is related to worse self-rated health for women, but no significant differences emerge among men and the negative relationship varies over age among women. Third, there are no gender differences in self-rated health among singles, but gender differences in self-rated health exist between widowed men and women, and health differences in self-rated health between the married and widowed converge among women over age, but persist among men.

A shortage of marriageable women in China and stigmatized unmarried women are two noticeable features of marriage markets in China. The health implications of these features are not yet clear. In this study, I that found both single men and women have worse health than their married counterparts. This finding is consistent with existing literature in China that single men are worse off in term of health (Gupta et al., 2010). However, this negative relationship disappears after accounting for omitted variable bias, which suggests no evidence that being single causes worse health in China. Similarly, single women also have worse health than their married counterparts, as I hypothesized given that social pressures and stigma against single women may trigger stress for single women. However, this negative association disappears once omitted variable bias is corrected. In addition, research in the U.S. shows that men gain more benefits out of marriage than women (Williams & Umberson, 2004), but there is no appreciable gender difference in the health benefit of marriage in the Chinese context. The finding shows that singlehood for men and women is associated with poorer self-rated health in the Chinese context, even though no causal evidence supports marital protective effects on health. The observed health premium associated with marriage may be the result of selection effects.

Additionally, life course perspectives suggest that the marriage-health relationship varies across life stages. This argument is only partially supported here, as there is no evidence to support marital protective effects on health and the relationship is constant over age for both single men and women. Due to strong social expectations for adults form their family and social norms in China, the life course perspective implies that the stress of being single may rise over age. This may be especially true for women, since Chinese societies tend to tolerate delaying marriage for men, but stigmatize women who delay marriage. However, my empirical evidence does not support the prediction of life course perspectives. One possible explanation is that those who remain single above a certain age may have already adjusted to circumstances or developed other interpersonal relationships that provide similar benefits to those obtained by getting married.

There is also no evidence showing that widowed men are worse off in terms of health than their married counterparts, while literature in the U.S. shows a strong marital protective effect of health for widowed men (Williams & Umberson, 2004). This might be because of mortality selection, in which healthier men are more likely to live longer than their spouses as well as survive through the loss of spouse. It is also possible that widowed men may recover from the loss of a spouse, and thus no evidence is found to show detrimental effects of being widowed on self-rated health among men. Furthermore, this relationship is also constant across age. By contrast, there is a marital protective effect of health among women, and this effect varies over age. Being widowed is related to poorer health than being married and the health differences between the married and widowed are wider at earlier life stages, then converge at later life stages. One possible explanation for this pattern is that as children mature and have more capacity and resources to support their aging parents, the gap converges over age. This convergence may also be explained by the role of elderly women in traditional family life. Elderly women are often suppliers of household chores and children care givers. Empirical evidence has shown that conducting chores and taking care of children may be harmful to elderly health and wellbeing (Chen & Liu, 2012), thus the growing up of grandchildren may relieve the work burden of the elderly. Consequently, the health gap converges at later life stages. If the first explanation is plausible, we should expect to see a similar age pattern among men, since widowed men can also receive more supports from their mature children. Results from three way interactions, as shown in Table 6, however, show that health differences between widowed and married women converge over age, but the same is not true among men. This result supports the argument that the role of elderly women as caregivers of grandchildren in traditional family life shapes health disparities between married and widowed women over age.

In sum, this study shows that marital protective effects of marriage vary by gender and vary across age. There is no evidence to support that men benefit from marriage and the marriage-health gradient is unchanged over age. However, widowed women have poorer health than married women and the gap is wider at younger life stages than older. The negative effects of being widowed on health persist with different analytical approaches. Most of the existing literature suggests that men are more vulnerable to exiting marriage and gain more benefits out of staying in marriage, but empirical evidence in China shows that women gain more health benefits from marriage and are more vulnerable to exiting marriage.

One mechanism by which men enjoy more health benefits of marriage is that marriage enhances better healthy behaviors and lifestyle, as women are more likely to be caregivers and monitor husbands' health behaviors (Umberson, 1992). In order to understand why there is no marriage protective effect on health for men, I conducted an auxiliary analysis to test whether marital status is related to health behavior, measured by current smoking status (Appendix C). Results from auxiliary analysis show that divorced and widowed men do not have higher log odds of being current smokers than do their married counterparts. Interestingly, being single is related to lower log odds of being a current smoker and the log odds of being current smokers increases over age.

Although the main purpose of this study is to investigate how the marriage-health relationship varies across gender and life stages, not to investigate potential behavioral mechanisms that might explain the marriage-health relationship, this auxiliary analysis provides certain evidence that the relationship between marriage and health behaviors is also different from theoretical predictions and empirical evidence from developed countries that marriage enhances healthy behavioral among men (Umberson, 1992).

6. Conclusions

In summary, this study has utilized large-scale, population-level, longitudinal data in China to investigate the relationships between marriage and self-rated health by gender and over the course of adulthood in a Chinese context, in which marriage markets and filial norm-related intergenerational supports are distinct from those found in Western developed countries. I employed OLS regression and linear regression with random- and fixed-effects models. Three main findings emerge from this study. First, being single is associated with poorer self-rated health than being married for both men and women, but the negative relationship disappears after taking into account omitted variable bias. Second, being widowed is related to worse self-rated health for women, but no significant differences emerge among men and the negative relationship varies over age among women. This pattern still persists with fixed-effects models. Third, there are no gender differences in self-rated health among singles, however, gender differences in self-rated health exist between widowed men and women. Widowed men are better off than widowed women. Moreover, health differences in self-rated health between the married and widowed converge among women over age, but persist among men.

These analyses were designed to investigate three theoretical perspectives developed to characterize patterns in Western countries. Notably, the gender and age patterns of marriage-health relationships deviate from patterns seen in Western developed countries, in ways that are understandable given features of Chinese marriage markets and family processes and norms. From a comparative perspective, this work indicates that marriage-health relationships shouldn't be expected to be identical across societies and should be understood with reference to specific social contexts and norms. Theoretically speaking, this work speaks to the argument that there is no single theory able to explain all observed health differences between married- and non- married people. Marital protection and marital selection work together in determining the marriage-health gradient (Lillard& Waite, 1995). Moreover, these two mechanisms might work differently for men and women, as well as for those at different life stages.

7. Tables and Figures

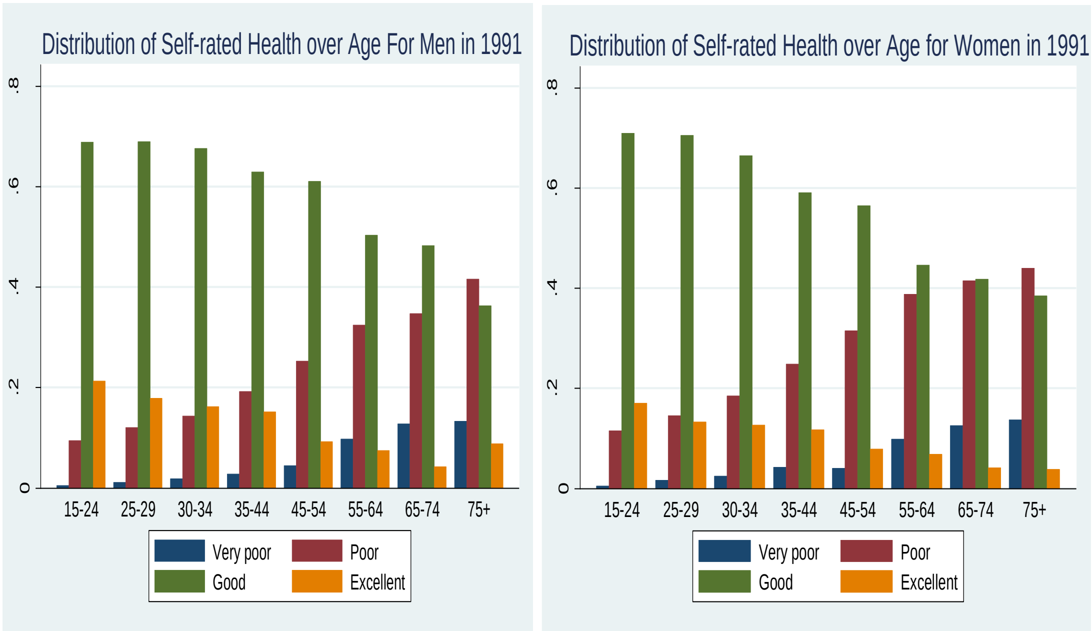

Figure 3: Distribution of Self-rated Health over Age by Gender in 1991

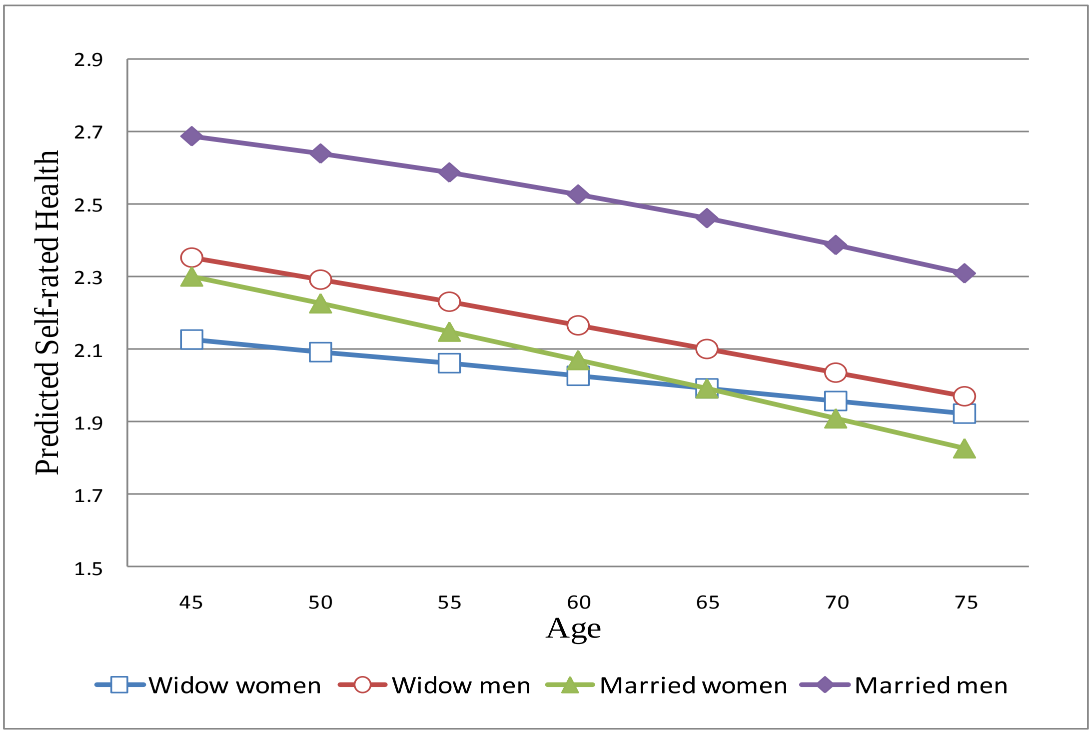

Figure 4: Predicted Self-rated Health Differences by Gender and Marital Status over Age

Table 7: Descriptive Table of All Variables

	Men					Women				
Variables	Obs [a]	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max
Self-rated health	25475	2.80	0.75	1	4	27929	2.70	0.75	1	4
Female	25475	0.00	0.00	0	0	27929	1	0	1	1
Single	25475	0.11	0.31	0	1	27929	0.07	0.26	0	1
Married	25475	0.85	0.36	0	1	27929	0.82	0.39	0	1
Divorced	25475	0.01	0.10	0	1	27929	0.01	0.09	0	1
Widowed	25475	0.03	0.18	0	1	27929	0.10	0.30	0	1
Age	25381	30.66	15.22	0.01	82.11	27859	30.61	15.76	0.06	86.67
Age squared	25381	11.72	10.35	0.00	67.42	27859	11.86	11.01	0.00	75.12
Stature (cm)	24929	167.2	6.40	135.5	189.5	27413	156.2	6.20	128.3	179
Highest level of education (primary school and below as reference)										
Primary school and below	8488	33.41				14422	51.95			
Upper middle or vocational school	9372	36.89				7904	28.47			
College and above	7543	29.69				5437	19.58			
Employed	25297	0.78	0.42	0	1	27769	0.65	0.48	0	1
Household income Per capita (logged)	25197	8.10	0.99	0.44	12.35	27619	8.08	1.00	0.44	12.35
Urbanization	25475	55.2	19.77	16.73	101.0	27929	55.63	19.69	16.73	101.6

[a] Age centered at age 15; [b] N represents person-times observations.

Table 8: Marital Status by Gender and Age Groups (%)

	Single	Married	Divorced	Widowed	Total
Age			Male		
15-24	82.56	17.3	0.14	0	2,156
25-29	23.34	76.06	0.51	0.09	2,168
30-34	5.96	91.93	1.91	0.2	2,516
35-44	1.87	96.18	1.48	0.47	6,211
45-54	1.41	95.48	0.98	2.14	5,333
55-64	1.13	92.95	0.8	5.12	3,886
65-74	0.92	86.79	0.92	11.37	2,278
75+	2.7	70.55	1.29	25.46	927
Total	10.67	84.96	1.06	3.31	25,475
			Female		
15-24	66.28	33.52	0.16	0.04	2,485
25-29	10.25	88.93	0.66	0.16	2,565
30-34	1.58	97.51	0.74	0.18	2,855
35-44	0.46	97.26	1.06	1.21	6,683
45-54	0.11	94.16	0.7	5.04	5,598
55-64	0.33	82.94	0.88	15.86	3,997
65-74	0.16	61.32	1.05	37.47	2,474
75+	0.94	27.44	1.1	70.52	1,272
Total	7.24	81.81	0.81	10.14	27,929

Table 9: Bivariate Regression Coefficients between Self-rated Health And Marital Status by Gender and Age Groups (Married as Reference)

	Single		Divorced		Widowed	
Age			Male			
15-24	-0.009	(0.034)	-0.465	(0.350)		
25-29	-0.035	(0.032)	0.011	(0.189)	0.920**	(0.441)
30-34	-0.208***	(0.055)	-0.035	(0.096)	0.186	(0.294)
35-44	-0.207***	(0.064)	-0.211***	(0.072)	-0.078	(0.127)
45-54	-0.255***	(0.085)	0.008	(0.102)	0.037	(0.069)
55-64	0.192*	(0.116)	-0.139	(0.138)	-0.096*	(0.056)
65-74	-0.148	(0.167)	0.137	(0.167)	0.027	(0.050)
75+	0.360**	(0.171)	-0.320	(0.245)	0.045	(0.064)
Total	0.253***	(0.015)	-0.076*	(0.045)	-0.300***	(0.026)
			Female			
15-24	0.015	(0.026)	-0.305	(0.301)	-1.055*	(0.601)
25-29	0.005	(0.041)	-0.042	(0.153)	-0.483	(0.315)
30-34	-0.371***	(0.100)	-0.022	(0.145)	-0.127	(0.297)
35-44	-0.430***	(0.127)	-0.099	(0.084)	-0.151*	(0.079)
45-54	0.191	(0.302)	-0.001	(0.119)	-0.188***	(0.045)
55-64	0.037	(0.208)	-0.082	(0.127)	0.011	(0.032)
65-74	0.711*	(0.390)	-0.289*	(0.154)	-0.001	(0.032)
75+	0.598**	(0.234)	0.122	(0.218)	0.020	(0.050)
Total	0.317***	(0.017)	-0.137***	(0.049)	-0.375***	(0.015)

Table 10: OLS, Random- and Fixed-Effects Estimation of Self-rated Health with Marital Status among Chinese Men Age 15 and Above

	(1)	(2)	(3)	(4)	(5)	(6)
Currently marital status (married as reference)						
Single	-0.057***	-0.058*	-0.037*	-0.031	0.080**	0.081
	(0.020)	(0.030)	(0.019)	(0.030)	(0.032)	(0.050)
Single*age		0.000		-0.000		-0.000
		(0.002)		(0.002)		(0.003)
Divorced	-0.067	-0.163	-0.056	-0.159	0.026	-0.052
	(0.050)	(0.112)	(0.049)	(0.112)	(0.067)	(0.167)
Divorced*age		0.003		0.003		0.002
		(0.003)		(0.003)		(0.005)
Widowed	0.048	-0.182	0.051	-0.111	0.068	0.158
	(0.034)	(0.132)	(0.032)	(0.133)	(0.049)	(0.186)
Widowed*age		0.005*		0.003		-0.002
		(0.003)		(0.003)		(0.004)
Age	-0.016***	-0.015***	-0.013***	-0.012***	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Age squared	0.003	0.002	-0.002	-0.003	-0.035***	-0.034***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)
Stature (cm)	0.001	0.001	0.002	0.002*		
	(0.001)	(0.001)	(0.001)	(0.001)		
Highest level of education (primary school and below as reference)						
Upper middle or vocational school	0.062***	0.061***	0.058***	0.058***		
	(0.014)	(0.014)	(0.014)	(0.014)		
College and above	0.095***	0.094***	0.098***	0.097***		
	(0.016)	(0.016)	(0.016)	(0.016)		
Employed	0.130***	0.129***	0.113***	0.112***	0.063***	0.064***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.019)	(0.019)
Household income per capita (logged)	0.032***	0.032***	0.024***	0.024***	0.021***	0.021***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.007)	(0.007)
Urbanization	-0.000	-0.000	-0.000	-0.000	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Province (Liaoning as reference)						
Heilongjiang	0.123***	0.123***	0.114***	0.114***		
	(0.027)	(0.027)	(0.027)	(0.027)		
Jiangsu	0.082***	0.083***	0.080***	0.080***		
	(0.023)	(0.023)	(0.023)	(0.023)		
Shandong	0.181***	0.182***	0.180***	0.180***		
	(0.023)	(0.023)	(0.023)	(0.023)		
Henan	-0.020	-0.020	-0.031	-0.031		
	(0.024)	(0.024)	(0.024)	(0.024)		

Hubei	-0.082***	-0.081***	-0.088***	-0.088***		
	(0.023)	(0.023)	(0.023)	(0.023)		
Hunan	0.022	0.022	0.016	0.016		
	(0.023)	(0.023)	(0.023)	(0.023)		
Guangxi	-0.151***	-0.151***	-0.156***	-0.156***		
	(0.022)	(0.022)	(0.022)	(0.022)		
Guizhou	-0.050**	-0.050**	-0.048**	-0.048**		
	(0.023)	(0.023)	(0.024)	(0.024)		
Constant	2.613***	2.603***	2.641***	2.631***	2.968***	2.969***
	(0.171)	(0.171)	(0.174)	(0.174)	(0.064)	(0.066)
Model	OLS	OLS	RE	RE	FE	FE
Person-times observations	25,475	25,475	25,475	25,475	23,707	23,707
N			8,142	8,142	6,374	6,374

***,**,* denotes significant level at 1%, 5%, and 10% respectively.
Robust standard error is presented in the parenthesis
[a] OLS represents ordinary least square regression; [b] RE represents random-fixed effects model; [c] FE represents fixed-effects model.

Table 11: OLS, Random- and Fixed-Effects Estimation of Self-rated Health with Marital Status among Chinese Women Age 15 and Above

	(1)	(2)	(3)	(4)	(5)	(6)
Currently marital status (married as reference)						
Single	-0.077***	-0.052	-0.073***	-0.059*	-0.002	-0.065
	(0.021)	(0.038)	(0.020)	(0.034)	(0.065)	(0.084)
Single*age		-0.000		0.001		0.005
		(0.004)		(0.003)		(0.005)
Divorced	-0.079	-0.145	-0.058	-0.167	-0.025	-0.200
	(0.049)	(0.109)	(0.047)	(0.108)	(0.064)	(0.156)
Divorced*age		0.002		0.003		0.005
		(0.003)		(0.003)		(0.004)
Widowed	0.012	-0.441***	0.011	-0.447***	0.010	-0.417***
	(0.021)	(0.084)	(0.021)	(0.084)	(0.034)	(0.125)
Widowed*age		0.009***		0.009***		0.009***
		(0.002)		(0.002)		(0.003)
Age	-0.021***	-0.017***	-0.020***	-0.015***	-0.011***	-0.008***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.003)	(0.003)
Age squared	0.010***	0.002	0.006***	-0.001	-0.029***	-0.036***
	(0.002)	(0.003)	(0.002)	(0.003)	(0.004)	(0.004)
Stature (cm)	0.001	0.001	0.000	0.000		
	(0.001)	(0.001)	(0.001)	(0.001)		
Highest level of education (primary school and below as reference)						
Upper middle or vocational school	0.044***	0.040***	0.048***	0.044***		
	(0.014)	(0.014)	(0.014)	(0.014)		
College and above	0.081***	0.076***	0.091***	0.085***		
	(0.016)	(0.016)	(0.016)	(0.016)		
Employed	0.064***	0.060***	0.054***	0.050***	0.018	0.016
	(0.012)	(0.012)	(0.012)	(0.012)	(0.015)	(0.015)
Household income per capita (logged)	0.022***	0.022***	0.016***	0.016***	0.018***	0.018***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)
Urbanization	0.000	0.000	-0.000	-0.000	0.002**	0.002**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Province (Liaoning as reference)						
Heilongjiang	0.149***	0.149***	0.140***	0.139***		
	(0.026)	(0.026)	(0.026)	(0.026)		
Jiangsu	0.109***	0.109***	0.109***	0.109***		
	(0.023)	(0.023)	(0.023)	(0.023)		
Shandong	0.239***	0.238***	0.235***	0.235***		
	(0.023)	(0.023)	(0.023)	(0.023)		
Henan	0.027	0.026	0.020	0.019		
	(0.023)	(0.023)	(0.023)	(0.023)		
Hubei	-0.021	-0.022	-0.031	-0.031		
	(0.022)	(0.022)	(0.022)	(0.022)		
Hunan	0.055**	0.054**	0.047**	0.046**		
	(0.023)	(0.023)	(0.022)	(0.022)		

Guangxi	-0.132***	-0.132***	-0.136***	-0.135***		
	(0.022)	(0.022)	(0.022)	(0.022)		
Guizhou	0.021	0.023	0.013	0.015		
	(0.022)	(0.022)	(0.022)	(0.022)		
Constant	2.844***	2.798***	2.955***	2.908***	3.145***	3.116***
	(0.161)	(0.162)	(0.163)	(0.163)	(0.063)	(0.064)
Model	OLS	OLS	RE	RE	FE	FE
Person-times observations	27,929	27,929	27,929	27,929	25,585	25,585
N			9,236	9,236	6,892	6,892

***,**,* denotes significant level at 1%, 5%, and 10% respectively.
Robust standard error is presented in the parenthesis
[a]OLS represents ordinary least square regression; [b]RE represents random-fixed effects model; [c] FE represents fixed-effects model.

Table 12: OLS, Random- and Fixed-Effects Estimation of Self-rated Health with Three-way Interaction between Gender, Marital Status and Age among Chinese Population Age 15 and Above

	(1)	(2)	(3)	(4)	(5)	(6)
Female	-0.098***	-0.078***	-0.096***	-0.076***		
	(0.007)	(0.011)	(0.007)	(0.011)		
Single	-0.080***	-0.084***	-0.066***	-0.065**	0.044	0.041
	(0.014)	(0.026)	(0.014)	(0.025)	(0.028)	(0.047)
Female*single		0.052		0.032		-0.076
		(0.037)		(0.035)		(0.092)
Single*age		0.001		0.001		0.001
		(0.002)		(0.002)		(0.003)
Female*single*age		-0.002		-0.001		0.003
		(0.004)		(0.004)		(0.006)
Divorced	-0.074**	-0.176	-0.058*	-0.171	0.005	-0.057
	(0.035)	(0.112)	(0.034)	(0.111)	(0.047)	(0.167)
Female*Divorced		0.036		0.007		-0.123
		(0.155)		(0.154)		(0.228)
Divorced*age		0.003		0.004		0.003
		(0.003)		(0.003)		(0.005)
Female*divorced*age		-0.001		-0.000		0.001
		(0.004)		(0.004)		(0.007)
Widowed	0.027	-0.183	0.026	-0.115	0.023	0.141
	(0.017)	(0.131)	(0.017)	(0.131)	(0.028)	(0.185)
Female*widowed		-0.251*		-0.332**		-0.520**
		(0.148)		(0.149)		(0.220)
Widow*age		0.005*		0.003		-0.001
		(0.003)		(0.003)		(0.004)
Female*widowed*age		0.005		0.006**		0.009**
		(0.003)		(0.003)		(0.004)
Age	-0.020***	-0.016***	-0.018***	-0.014***	-0.007***	-0.005**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Age squared	0.007***	0.002	0.003*	-0.002	-0.032***	-0.035***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Constant	2.964***	2.742***	3.030***	2.817***	3.058***	3.048***
	(0.034)	(0.123)	(0.034)	(0.125)	(0.045)	(0.046)
Model	OLS	OLS	RE	RE	FE	FE
Person-times observations	53,404	53,404	53,404	53,404	49,292	49,292
N			17,378	17,378	13,266	13,266

All models control for age, age squared, stature, highest level of education, employment status, logged household income per capita, urbanization and province dummies.
***,**,* denotes significant level at 1%, 5%, and 10% respectively.
Robust standard error is presented in the parenthesis
[a] OLS represents ordinary least square regression; [b] RE represents random-fixed effects model; [c] FE represents fixed-effects model.

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CHAPTER 2

GENDER, MARITAL TRANSITIN AND BMI CHANGE IN CHINA

1. Introduction

Worldwide, between 1980 and 2013, the percent overweight and obese among adults (body mass index [BMI] ≥25) increased from 28.8 percent to 36.9 percent in men, and from 29.8 percent to 38.0 percent in women (Ng et al, o2014). The rapid rise in the prevalence of obesity has become a major health concern in both developed and developing countries. The prevalence of obesity (body mass index [BMI] ≥30) was about 35 percent among U.S adults in 2010. In developing countries, although the prevalence of overweight and obesity is lower than that in Western developed countries, obesity is increasing at a rapid pace. For instance, in China, the prevalence of obesity increased from 2.9 to 11.4 percent among men and from 5.0 to 10.1 percent among women between 1993 to 2009 and is expected to continue to grow rapidly in the coming future (Xi et al., 2012). This alarming increase in the prevalence of obesity in China and other developing countries has prompted academic and policy interest in understanding the potential factors at different levels that explain the weight change in different social contexts (McLaren, 2007; Monteiro, Moura, Conde, & Popkin, 2004; Ng et al, 2014; Popkin, 1999).

Scholars from various disciplines have investigated the trend toward a worldwide obesity epidemic, and many factors, from the societal to the biological, have been proposed as contributors (Popkin, 1999; Popkin, Adair, & Ng, 2012). Many social scientists have investigated the socioeconomic and demographic determinants of obesity. From a macro perspective, economic development and urbanization raise the overall living standard in developing countries (Popkin, 1999). These macro-societal changes then lead to changes in behavioral factors, such as a more high calorie diet, lower levels of exercise, and a more sedentary lifestyle (Monda et al., 2007).

Some research also suggests that singletons are at higher risk of being overweight or obese, relative to their non-singleton counterparts (Hunsberger et al., 2012; Jing, 2000). Among social determinants, much research has investigated the relationship between socioeconomic status and weight status (Monteiro et al., 2004; Paeratakul, Lovejoy, Ryan, & Bray, 2002; Sobal & Stunkard, 1989). Research shows that socioeconomic status is an important social determinant of weight status and the gradients of social determinants on weight status vary across developed and developing countries and are gender-specific. For example, there is a strong association between education and weight status, but the direction is different in developing countries and developed countries (McLaren, 2007; Monteiro et al., 2004). In developed countries, there is an inverse relationship between education and weight status for women, but the pattern is less clear for men. However, there is a positive association between education and weight status in developing countries. In China, the pattern of the education-BMI relationship for women converts over time from the developing country pattern to the pattern of developed countries (Jones-Smith, Gordon-Larsen, Siddiqi, & Popkin, 2012). Findings from these studies show that the gradients of social determinants on weight status or health are embedded in concrete social contexts and are gender specific.

Marriage is another factor commonly linked to weight status in developed countries. For example, in the U.S., married individuals tend to live longer, are healthier, and are also happier (Lillard & Panis, 1996; Williams & Umberson, 2004; C. M. Wilson & Oswald, 2005). This marriage-health relationship also has been examined for different dimensions of health, including overall health status (Williams

& Umberson, 2004), health behaviors (Umberson, 1987) and substance use (Duncan, Wilkerson, & England, 2006).

However, the relationship between marital status changes and weight status changes is less established (Dinour, Leung, Tripicchio, Khan, & Yeh, 2012; Umberson, Liu, & Powers, 2009). For instance, Sobal, Rauschenbach, & Frongillo's (2003) study of the marriage-BMI relationship among U.S. adults found that there were weight gains only for women, but not for men with the transition from single status into marriage. Yet, among U.S adults, Umberson et al (2009) show that neither men nor women gain weight while entering a union, compared to those remaining single.

Moreover, marriage-BMI relationships may differ substantially across national contexts, in conjunction with development trajectories, marriage markets and family structures. Schmeer (2012) examines the relationship between marital transition and BMI change among Mexican adults using longitudinal data from the Mexico Family Life Survey. Unlike findings from the United States cited in the preceding paragraph, results indicate a significantly larger weight gain for those entering marriage than those remaining single for both men and women, and there is no association between marital dissolution and weight change. The author concludes that a stable marriage market and strong family ties in Mexico explain these different findings from the United States, since remarriage is not an option for those who exit a union. Few other studies on the topic have been conducted in low- and middle-income countries, where the relationship between marriage and weight change remains underexplored (Dinour, Leung, Tripicchio, Khan, &Yeh, 2012; Hanson, Sobal, &Vermeylen, 2014).

In this paper, I extend research on the relationship between gender, marital transition and BMI change to the case of China, which has different marriage markets and gender norms from those found in the United States. Analyzing the China Health and Nutrition Survey (CHNS), I address the following two questions: (1) Do BMI changes differ according to family formation and dissolution pathways? and (2) Are there gender differences in these relationships?

Results show that both men and women gain weight following the transition from never-married to married, compared to those in stable marriages. Also, continuously single men and women gain less weight than those in stable marriages. Moreover, there is a notable gender difference in weight change among the never-married population. Never-married women, on average, lost more weight than never-married men. Weight remained stable for men and women among those who transition from marriage into widowhood or divorce. I argue that these results can be understood in the context of a gender-differentiated marriage market, highly-stable marriages and few opportunities for remarriage.

2. Theoretical Framework

Three theoretical frameworks have been proposed to explain the link between marital transition and weight change: the marriage market model, the resources model, and the crisis model. First, the marriage market model suggests that individuals who are not married have a stronger incentive to maintain their weight status in order to attract a partner. In contrast, married individuals are less concerned about their own body weight since they are no longer in the marriage market (Averett, Sikora, &Argys, 2008; Umberson et al., 2009). With this argument, there could be a gender difference in weight change related to marital transition if physical appearance plays a more important role for women than for men in the marriage market. To the extent that thinness is a desired characteristic in a given society, never-married women would be expected to gain less weight than never-married men, in order to maintain their attractiveness (Averett et al., 2008; Teachman, 2013).

From a different perspective, weight change associated with marital transition can be viewed from the perspective of a resources model, which emphasizes that married- and non-married people enjoy different amounts of resources, resulting in disparate health outcomes. Married people tend to have better financial resources, enjoy more social support, and live healthier and less risky lifestyles than non-married people (Duncan et al., 2006; Lillard& Panis, 1996; Umberson, 1987). At the same time, regarding weight change, married people more frequently eat with others and have regular meals than non-married people (Averett et al., 2008; S. E. Wilson, 2012). Married people also spend less time on exercise than their unmarried counterparts, especially for women (Nomaguchi & Bianchi, 2004). Thus, married people might be expected to be heavier than their non-married counterparts, and the entry into marriage and the exit from marriage might be associated, respectively, with weight gain and weight loss. The crisis model emphasizes the role of marital transition, especially marital dissolution, in affecting weight change. Marital dissolution is a stressful life event and may trigger changes in an individual's behavior, health and psychological wellbeing, which could contribute to weight gain or loss (Umberson et al., 2009).

These two theoretical frameworks also provide insightful perspectives on understanding gender differences in the association between marital transition and BMI change. One mechanism that marriage confers health is that married people have regular and healthy lifestyle and women tend to be health care providers or attempt to monitor and control health behaviors of their spouses, men thereby enjoy more health benefits than their women within marriage (Umberson, 1987, 1992). Existing literature also shows that exit from of marriage has detrimental effects on health and adverse effects are especially strong for men (Elwert & Christakis, 2008; Lee, DeMaris, Bavin, & Sullivan, 2001).

[Table 1 about here.]

Table 1 summarizes the predictive relationships between marital transition and weight change and gender differences in weight change related to marital transition by each theoretical framework. There are similarities and dissimilarities in terms of predictions about weight changes among these theoretical frameworks. For example, both the marriage market and resources models suggest that transition from never-married to married is related to weight gain and both marriage market and crisis models predict that transitions from married to widowed or divorced are related to weight change. However, they provide different explanations for the same observed weight change. The marriage market model provides an explanation for weight change related to every marital transition and predicts that exit from marriage or staying out of marriage are related to weight loss relative to being continuously married. Moreover, the marriage market model predicts that women may lose more weight than men, if physical appearance plays a more important role for women than for men in marriage markets.

Resources and crisis models, respectively, emphasize weight change related to entry into or exit from marriage. With regard to gender differences, the resources model expects that men will gain less weight than women, given suggestions in existing research that men benefit more in terms of resource gains than women from marriage. From the view of the crisis model, men are more vulnerable to exit from of marriage, and thus one would expect men to have a more substantial weight change than women when facing and coping with stress provoked by marital dissolution.

3. China Context

3.1 Gender, Union Formation and Social Stigma

China has undergone dramatic socioeconomic and cultural change in the last several decades. Accompanying these socioeconomic and cultural changes, the pattern of family formation has changed, with a tendency toward becoming "deinstitutionalized"(Davis & Friedman, 2014). One noticeable trend related to marriage in China is delayed age at first marriage for both men and women. However, the tendency of delayed marriage has not yet translated into high proportions never married in the population, and unmarried men and women face strong social expectations and pressures to get married and there are strong gender differences in social attitudes related to unmarried adults in Chinese contexts (Davis & Friedman, 2014; Fincher, 2014; Qian & Qian, 2014).

Excess men in the marriage market is a pressing demographic issue in China. One foreseeable consequence of this highly-skewed sex ratio in marriage markets is that many men will be lifelong bachelors in China (Das Gupta, Ebenstein, & Sharygin, 2010; Ebenstein & Sharygin, 2009). In China, a patrilineal and patriarchal society, men face strong familial expectations to form their own families and carry on their fathers' lines, but delayed marriage is more socially acceptable for men than for women. There are three reasons that social attitudes are more tolerant to unmarried men and more harsh to unmarried women in China. First, men are expected to pay bride price, according to Chinese customs. Sometimes the bride price is high and becomes an obstacle for unmarried men in finding a spouse. In response to high bride price, unmarried men unwillingly postpone their timing of marriage in order to accumulate economic resources for marriage (Jiang & Sánchez-Barricarte, 2012; Oppenheimer, 1988; Wei & Zhang, 2009).

A second reason is that female marital hypergamy still prevails in Chinese contexts (Du, Wang, & Zhang, 2014). While the gender gap in education has narrowed over time, gender inequality in wages and employment status as well as disadvantages for married women and mothers in the labor markets remain (Zhang, Hannum, & Wang, 2008). Moreover, gender differences in social attitudes related to marriage are still resistant to change, and women are still expected to play a traditional role within marriage (Fincher, 2014). Scholars have also argued that women implicitly prefer older men with better socioeconomic standing than themselves, and the age gap between wives and husband has widened in recent years because of increasing economic pressures and worsening gender equality in labor markets (Fincher, 2014; Mu & Xie, 2014; Qian & Qian, 2014).

Getting married is still viewed as the “gold standard” of family life in China, although there is a tendency of deinstitutionalization of marriage (Davis & Friedman, 2014). Social expectations and pressure toward unmarried adults, especially for women, from their parents, other family members and society are strong and harsh. Unlike the case of men, who are able to marry younger women, unmarried women in their late 20shave limited options in terms of marriageable men and are stigmatized as “leftover women” (Fincher, 2012).

This pattern is in direct contrast to the US context, where the decision of marriage is generally viewed as more of an individual free choice, subject to less collective pressure from families than in the Chinese case. Marriage in the U.S. is highly deinstitutionalized, and the choices of timing, formats and even definition of marriage or family are individualized and, in relative terms, may be less subject to criticism or stigmatization by significant or insignificant others (Cherlin, 2004, 2005). Given this stigma and hostile social environment in China, single Chinese women are likely to have strong pressure or motivation to change their behaviors in order to seek a partner.

Overall, social expectations and pressures related to union formation are substantially different for men and women. Unmarried adult Chinese women may face stronger social pressure to marry than unmarried Chinese men. This expectation or pressure, perhaps, may provide a strong incentive for unmarried women to maintain their weight. Scholars have long speculated about gender differences in the weight change expected with marital transition. To the extent that body weight plays a more important role in marriage markets for women than for men (Averett et al., 2008; Umberson et al., 2009; S. E. Wilson, 2012), we might expect to see a gender difference in weight change with marital transition. However, empirical evidence outside of China does not support this argument (Schmeer, 2012; Umberson et al., 2009). Different social expectations or pressures on unmarried men and women in China present a very different context in which to test gender differences in weight change related to marital transition.

3.2 Low Divorce and Remarriage Rates

Distinguishing features of the China and American marriage markets provide important contextual differences for testing marriage market and crisis frameworks for understanding marital transition-related weight change. One key distinction is that divorce and remarriage rate in the U.S. are higher than in China. The crude divorce rate was about 7.3per 1000 total population in the U.S in 2006**,** while it was about 1.59 in China in 2007. The remarriage rate was about 10.24 percent in 2007 in China among previously married, compared to about 36 percent in 2006 in the U.S. (Kreider, 2006; Wang & Zhou, 2010).According to the crisis model, exiting marriage is a stressful life event. Thus, weight loss or gain, depending on how people respond behaviorally and psychologically to stressful events, is expected to relate to exiting marriage. Guided by the crisis model, we would expect to see a similar pattern of weight change after exiting marriage in the Chinese context as in the U.S. context.

However, from a marriage market model perspective, weight loss after exiting marriage in the U.S. is the result of strong incentives to find another partner. From this perspective, Chinese marriage markets provide an interesting comparison, in that the remarriage rate after marriage and divorce is quite low China. According to the marriage market model, weight change is explained by person's motivation for attracting a partner. Because such opportunities in China after divorce or widowhood are rare, we might expect no association between exiting marriage and weight changes in the Chinese context.

4. Data and Methods

4.1 Data

Data from the China Health and Nutritional Survey (CHNS) is used to examine the association between marital transition and BMI change. I limit my analysis to respondents above the minimum legal age for marriage in China: age 20 and above for women and age 22 and above for men. In addition, only the 1991 to 2009 questionnaires collected data on BMI and other relevant covariates. Therefore, the sample is further limited to survey rounds from 1991 to 2009. Additionally, the sample is limited to person-time observations with valid values on marital transition, BMI and control variables. Women pregnant at the survey time are also excluded from the analytical sample. The final analytical sample includes 12,565 people and 38,059 person-time observations.

4.2 Outcome Variables

Body mass index. Body mass index is calculated based on measured weight and height, and is defined as weight (kg) divided by height (m) squared. BMI is transformed to log BMI. Additionally, the main focus in this study is BMI change, and so I further construct a dependent variable as log BMI change between time t and time t+1. Instead of examining absolute weight change, I focus on proportionate weight change. Proportionate weight change can better capture the magnitude of weight change, regardless of absolute weight status. Figure 1 presents the distribution of BMI by survey year and gender. The prevalence of under-weight reduces substantially, meanwhile, the prevalence of overweight and obesity has also risen for both men and women between 1991 to 2009.

[Figure 1 about here.]

4.3 Explanatory Variables

Marital transition. In this study, marital transition is the main analytic variable. There are five categories of marital status in the original questionnaire: never-married, married, divorced, separated and widowed. Because there is a small proportion of respondents reporting divorce and separation in the sample, I combined divorced, separated and widowed as one category. Then, I constructed five categories of marital transition based on these three categories of marital status. As shown in Table 2, the five categories of marital transition include *continuously never-married* (N=1128), *entry into marriage* (N=409), *exit from marriag*e (N=781), *continuously out of marriage* (N=2040) and *continuously married* (N=33765). The reference group is continuously married in all analyses.

[Table 2 about here.]

4.4 Control Variables

Description of all variables used in the analysis is presented in Table 3. There are time-invariant and time-varying variables in my analysis. Time-invariant variables include *female*, *years of schooling*, and *stature*. The time-varying variables include *age, age squared*, *employment status, number of children, household income per capita*, and *level of urbanization*. Age is centered to the lowest age (age 22 for men and age 20 for women) in the analytical sample. *Employment status* at time 1 is coded as 1 if the individual is employed and 0 otherwise. Then, change in employed status between two time points is coded as 0 if the employment status is unchanged between time 1 and time2. Becoming unemployed from time 1 to time 2 is coded as 1 and becoming employed is coded as 2. Becoming unemployed or employed are both salient life transitions and are potentially associated with weight change. Moreover, the decision of entering or exiting labor markets is closely linked to the decision of getting married or exiting marriage, especially for women (Pettit & Hook, 2005; Zhang et al., 2008).

The information about *number of children* is obtained from women's birth histories. Because the survey only collected birth histories from married women, I imputed number of children as 0 for never-married women. This imputation should be reasonable in the Chinese context, due to conservative social norms and attitudes toward premarital childbearing. Childbearing within marriage still prevails in Chinese contexts, and thereby the weight change related to marital transition may result from parenthood, especially for women. *Household income per capita* is inflated to 2009 price levels and is transformed to log form.

Urbanization reflects overall economic development, education, sanitation, and transportation at the community level. Prior research in China has suggested that level of urbanization is a strong predictor of individual BMI (Monda, Gordon-Larsen, Stevens, & Popkin, 2007; Popkin, 1999).

4.5 Analytical Approach

In this study, I apply a change score regression model to investigate the relation between weight change and marital transition. There are two types of change score models-unconditional and conditional change score models. The difference between unconditional and conditional change score models is whether the dependent variable at time 1 is included in the model. The unconditional change score approach doesn't include the dependent variable at time 1 and assumes that changes in the dependent variable between time 1 and 2 are independent of the dependent variable at time 1, presuming there is no phenomenon of "regression to the mean" (Finkel, 1995). However, this assumption is likely to be violated for the case of weight change. The conditional change score model, which includes the dependent variable at time 1 as a predictor, is thereby applied to test the relationship between marital transition and change in BMI. The change score model (change score model refers to conditional change score model, hereafter) also allows the researcher to control for unobserved heterogeneity. This property is important in understanding weight change, since genetics could be an important factor affecting individual weight status. Considering the following model, where t denotes time. ΔY represents difference between log BMI at time 2 and at time 1 and Y_1 denotes log BMI at time 1. β represents coefficients of independent variables and X denotes all predictors in the analysis. ϵrefers to residuals.

$$\Delta Y = \beta_0 + \beta X + \gamma Y_1 + \epsilon$$

Because of the statistical phenomenon “regression to the mean”, the coefficients of log BMI at time 1, denoted by $\gamma$are likely to be negative.

I first test the main effects of marital transition on BMI change using the whole sample in the analysis. Next, I investigate whether there is a gender difference in the effects of marital transition on weight change by adding an interaction term between gender and marital transition variables. An auxiliary analysis is conducted with the interaction between marital transition and initial weight status among women to examine whether weight change related to marital transition depends on initial weight status among women.

5. Results

5.1 Whole-sample Analysis

[Table 4 about here.]

A multivariate analysis of the relationship between marital transition and weight change is presented in Table 4**.** Model (1) examines the relationship between marital transition and weight change, controlling for demographic characteristics, with a change score model. Both entry into marriage and being continuously out of marriage are associated with weight gain, and continuously never-married is associated with weight loss. There is no association between marital transition and weight change among those who exit from marriage. Model (2) includes weight status at time 1 in order to take into account the fact the magnitude and direction of weight change between time 1 and 2 depends on weight status at time 1. As expected, the coefficients between weight at time 1 and changes in weight between time 1 and 2are negatively associated. The positive relationship between continuously out of marriage disappears after adding prior weight status in the model, but the coefficients of continuously never married and entry into marriage are still statistically significant**.**

Model (3) incorporates stature and years of schooling to account for overall nutrition status and socioeconomic status, which are stable over time and are determined in early adulthood. Both stature and years of schooling, as expected, are associated with better self-rated health. The relationships between marital transition and self-rated health persist in this specification. Employment status at time 1 and changes in employment status between the two time points are included in model (4). Clearly, there is a strong association between change in employment status and weight change. Becoming unemployed is associated with weight gain, but becoming employed is related to weight loss, relative to those who remain in the same employment status across time points. The relationship between marital transition and weight is unchanged, net of initial employment status and change in employment status between the two time points.

In model (5), family factors are added into the models. The coefficient for continuously never married is robust and the coefficient for entry into marriage attenuates from 0.017 to 0.014, suggesting that the differences in weight between those who entry into marriage and continuously married individuals is partly explained by childbearing and family economic resources. Nonetheless, entry into marriage is still associated with large weight gains compared to continuously married individuals and the effect is statistically significant at $p<0.01$.Model (6) adds the level of urbanization among communities. As expected, a high level of urbanization is strongly associated with weight gain.

In summary, Table 4 shows that continuously never-married people lose more weight, net of demographic variables, socioeconomic status, childbearing, family resources and level of urbanization, compared to those continuously married. Continuously never-married people, on average, increase 0.8 percent of BMI relative to continuously married people. Additionally, those who transitioned from never-married to married gained much more weight than continuously married people. This finding is consistent with findings from Mexico and is different from the U.S (Schmeer, 2012). This result supports that the notion, associated with the marriage market hypothesis, that continuously never-married people are more conscious about their weight than continuously married people. Moreover, we can see that being continuously divorced, continuously widowed, and exiting a union is not associated with weight changes. These findings are substantially different from the U.S., where researchers show that marital dissolution is associated with weight gain or loss (Dinour, Leung, Tripicchio, Khan, &Yeh, 2012).

5.2 Analysis of Gender Differences

[Table 5 about here.]

Further, to test whether BMI status plays a different role in marriage markets for women than for men, I examine whether there is a gender difference in weight change related to marital transition. Results are presented in Table 5. Model (1) is identical to model (6) in Table. Interaction terms between gender and marital transition are added in model (2). One clear result we can see is that the coefficient of the interaction term between continuously never-married and gender is -0.011 and statistically significantly at the $p<0.05$ level, suggesting that there are gender differences in weight change between continuously never-married men and women. I, then, analyze the relationship between marital transition and BMI with male and female samples separately to examine whether marital transition matters for both men and women. The result shows that continuously never-married women lose more weight than their continuously married women, however, there is no difference in weight change between continuously never-married and married men.

It is possible that health issues explain the relationship between weight loss and being continuously never-married. Indeed, unhealthy individuals are less likely to get married and, at the same, could be losing more weight than their healthy counterparts. There are two reasons that I believe this relationship is not resulting from a health issue. First, the coefficients of the interaction terms between continuously never-married and gender are -0.08 and -0.11 in model (1) and model (2), respectively, suggesting continuously never-married people, on average, reduce 0.8 percent and 1.1 percent of their total BMI. If it is a health issue that causes the weight loss, we would expect sharp weight loss. Second, continuously never-married people are mainly at the age of early adulthood, and thus the chance of continuously never-married people suffering from major health issues and impeding finding a spouse should be low. Based on these two reasons, I believe that the reduction of BMI among continuously never-married people is the result of incentives to maintain or lose weight to attract a spouse, rather than of health issues.

Table 6 examines whether the relationship between weight change and marital transition among women depends on initial weight status. The preceding analysis has shown that being continuously never married is associated with weight loss relative to being continuously married and that the pattern is more profound for women. If the incentive of seeking a partner is the driving force of maintaining weight, the relationship between weight change and marital transition, correspondingly, is likely to depend on initial weight status. Model (1) presents the same model specification as model (6) in Table 5 with the women's sample only. The pattern is similar to the pattern of analysis with full sample. Being continuously never married is related to a 0.8 percent BMI loss and entry into marriage is related to a 2.6 percent BMI gain relative to being continuously married among women. Model (2) adds an interaction term between marital transition and initial BMI status to investigate whether the relationship varies across different levels of BMI at time 1. Results show that the relationship between continuously never married and change depends on initial weight status. Every 1 unit increase in initial BMI is related to additional 9.5 percent BMI loss for continuously never married, relative to continuously married women.

6. Conclusions

This study tests the relationship between marital transition and weight change using three theoretical perspectives: the marriage market model, the resources model, and the crisis model. Three main empirical findings emerge from this study. First, there are gender differences in weight change related to marital transition. There is no difference between continuously never-married and married men in weight change, but continuously never-married women gain less weight than their married counterparts. Second, both men and women gain substantial weight when entering marriage and there is no gender difference in weight change. Third, exit from marriage or being continuously out of marriage is not associated with weight change for either men or women.

Gender differences in weight change related to marital transition is one central interest in the research about marriage-BMI relationships. The marriage market model predicts that there are gender differences in weight change related to marital transition if physical appearance is more important for women than for men in the marriage market, yet empirical evidence in the U.S. does not appear to support this argument. Nevertheless, there is evidence from this study to support the marriage market model.

One possible reason why scholars failed to find gender differences in weight change related to marital transition in the U.S. is that marriage decisions in the United States are less subject to pressure from family or social expectations than in China, and there is weak social pressure or stigma against unmarried women. By contrast, in Chinese society, men and women face strong social expectations and pressure from families and society to form their own marriage. Along with expectations or constraints of female marital hypergamy, Chinese women face strong social stress or stigma if they remain single above certain age. The combination of these factors may explain why there are gender differences in weight change related to marital transition in China, but not in the U.S., since Chinese women have stronger incentives or stress to maintain or loss their weight for seeking a partner.

The marriage market and crisis models both hypothesize that there is weight change related to exit from marriage, while each model provides different explanations for this relationship. From the view of the marriage market model, weight loss after marital transition is driven by the motivation of seeking another partner. From the crisis model's perspective, weight change is the result of stress provoked by marital dissolution. Empirical evidence from the U.S. largely supports that there is weight change related to marital dissolution, but does not allow for distinguishing which theoretical model is at play in the U.S. context, since both theories have the same predictions of the relationships between marital transition and weight change. In this regard, empirical evidence from this study in China permits these theoretical distinctions.

Results from this study show that there is no association between exit from marriage and BMI change and support the marriage market hypothesis. In the U.S. marriage market characterized by high divorce rates and remarriage after marital dissolution, individuals may lose weight after marital dissolution in order to seek a partner, whereas the marriage market in China is conservative and remarriage is rare after marital dissolution. If there is weight change after marital transition in China, then this weight change is likely to be explained by the crisis model. Nevertheless, if the marriage market model is correct, correspondingly, there would be no association between marital transition and weight change due to the lack of remarriage markets in China.

I also test a two-way interaction between marital transition and age with the female and male samples separately and a three-way interaction between gender, marital transition and age to examine whether the relationship between marital transition and BMI varies across the life course. On one hand, it is more difficult to lose weight at older ages than at younger ages, even though seeking a new partner may be a strong incentive. It may be less likely to have substantial weight loss at older ages than younger ages. One the other hand, weight status may be less a relevant consideration for seeking a partner at older ages than at younger ages. However, there is no statistically significant effect associated with the interaction term between martial transition and age. Perhaps this non-finding occurs because the compositions of exit from marriage or continuously out of marriage in the analytical sample are mainly widows and widowers, who tend to be older than those divorced and separated. Therefore, the analysis is not able to discern the gradients of marital transition and BMI over age.

Although this study shows that marital transition is associated with weight change, the health implications of connections between weight change related to marital transition, heath and health behaviors are not conclusive. The percentage of weight change is non-trivial, but whether and at what levels weight change has substantial implications for physical health is not clear. Moreover, marriage seems to link to both good and bad health behaviors that are associated with weight gain. Married people are more likely to quit smoking and to spend less times on exercise and these two factors are related to weight gain (Nomaguchi & Bianchi, 2004; Umberson, 1987). The health implications of the connections between weight change related to marital transition, health and health behaviors are ambiguous and thereby require more research in the future.

More broadly, these findings suggest that marriage-BMI relationships may vary according to marriage markets and prevailing gender norms related to union formation. Comparing findings for the case of China with those from prior studies in other settings, it is possible to speculate that gender differences in weight change related to marital transition are smaller in societies with high gender equality in labor markets and with prevalent marital homogamy. Gender differences would be expected to be greater in societies with gender inequality and sex segregation in labor markets, along with high levels of female marital hypergamy in marriage markets. Moreover, local marriage market features, such as divorce and remarriage rates, should be also taken into account in order to test the relationship between marital transition and BMI. Future researchers should investigate this topic with an international comparative research design to disentangle complex relationships between weight change, gender, marriage markets and gender and social norms related to family formation.

7. Tables and Figures

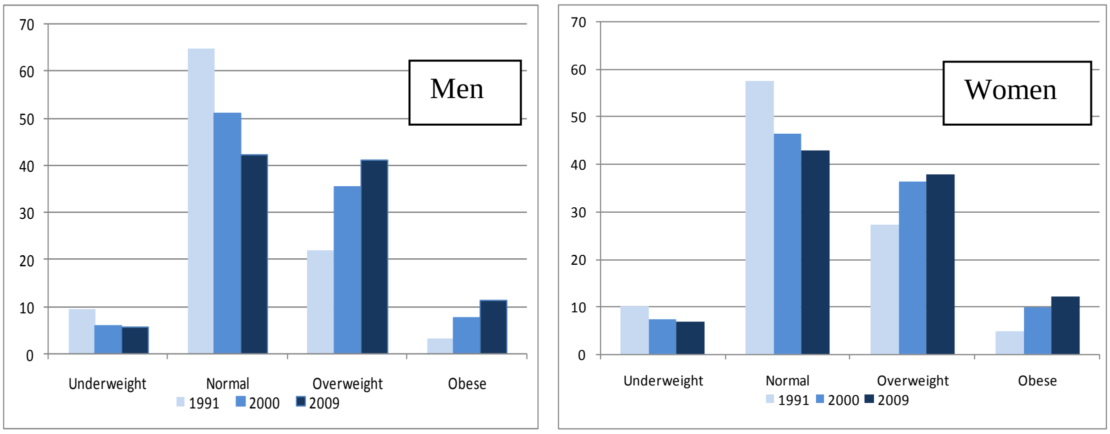

Figure 1: Distribution of Weight Status over Survey Year by Gender

Table 7: Summary of Theoretical Perspectives on Marriage-BMI Relationships

Continuously married as reference	Entry into marriage	Continuously never-married	Exit from marriage	Continuously divorced/widowed
Marriage Market				
Weight change	+	−	−	−
Gender diff.	N	W−	W−	W−
Resources Model				
Weight change	−	N		
Gender diff.	M-	N		
Crisis Model				
Weight change			− or +	N
Gender diff.			M− or +	N

M denotes men and W denotes women; + denotes weight gain; − denotes weight loss; N denotes no association/no difference; Empty cell denotes lack of theoretical hypothesis

Table 8: Descriptive Table of Marital Transition

Marital Transition between T1 and T2	Frequency	Proportion
Continuously married	33,765	0.885
Continuously never-married	1,128	0.030
Entry into marriage	409	0.011
Continuously out of marriage [a]	2,040	0.054
Exit from marriage [b]	781	0.025

[a] Continuously out of marriage includes continuously separated, divorced and widowed; [b] Exit from marriage represents transition from married to separated, divorced or widowed.

Table 9: Descriptive Table of all Variables

	Mean	Std. Dev.	Min	Max
Dependent variables				
BMI, T1	22.56	3.13	13.06	43.37
BMI change, T1-T2	0.26	1.75	-13.69	12.63
BMI (logged), T1	3.12	0.14	2.57	3.77
BMI change (logged), T1-T2	0.01	0.08	-0.50	0.59
Independent variables				
Continuously married	0.89	0.32	0	1
Continuously never-married	0.03	0.17	0	1
Entry into marriage	0.01	0.10	0	1
Exit from marriage	0.02	0.13	0	1
Continuously out of marriage	0.05	0.22	0	1
Women	0.54	0.50	1	2
Age (center at 20), T1	27.61	14.01	.03	80.83
Age square, T1	9.58	8.84	0	65.33
Stature (10cm)	16.14	0.82	12.83	18.95
Years of schooling	7.41	4.12	0	18
Employment status, T1	0.75	0.43	0	1
Number of children, T1	1.98	1.28	0	9
Number of children change, T1-T2	0.026	0.173	0	3
Household per capital (logged). T1	8.07	0.99	0.44	12.35
Household per capital change (logged), T1-T2	0.20	1.05	-8.03	8.92
Urbanization, T1	57.89	19.89	16.73	106.58
Urbanization change, T1-T2	3.50	7.99	-37.45	43.14

Table 10: OLS Estimation of BMI (logged) Changes between Time t and t+1 with Marital Transition among Chinese Population

	(1)	(2)	(3)	(4)	(5)	(6)
Marital transition (continuously married as reference)						
Continuously never-married	-0.004*	-0.007***	-0.006***	-0.007***	-0.008***	-0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Entry into marriage	0.018***	0.017***	0.017***	0.017***	0.014***	0.014***
	(0.005)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)
Continuously out of marriage	0.003**	-0.001	-0.000	-0.000	-0.000	-0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Exit from marriage	-0.002	-0.004	-0.003	-0.003	-0.003	-0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Age T1 [a]	-0.000	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age squared T1	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Females	-0.001	0.001	0.006***	0.005***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
BMI (logged) T1		-0.135***	-0.138***	-0.140***	-0.143***	-0.144***
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Stature (10cm)			0.004***	0.004***	0.003***	0.003***
			(0.001)	(0.001)	(0.001)	(0.001)
Years of schooling			0.000**	0.000*	-0.000	-0.000*
			(0.000)	(0.000)	(0.000)	(0.000)
Employment status (Yes=1) T1				-0.008***	-0.007***	-0.006***
				(0.001)	(0.001)	(0.001)
Employment status T1-T2 (the same as reference)						
Unemployed				0.004***	0.004***	0.004***
				(0.001)	(0.001)	(0.001)
Employed				-0.006***	-0.006***	-0.005**
				(0.002)	(0.002)	(0.002)
Number of children T1					-0.000	-0.000
					(0.000)	(0.000)
Number of children T1-T2					0.001	0.002
					(0.003)	(0.003)
Household per Capital (logged) T1					0.004***	0.003***
					(0.000)	(0.001)
Household per Capital (logged) T1-T					0.002***	0.002***
					(0.000)	(0.000)
Urbanization T1						0.000***
						(0.000)
Urbanization T1-T2						0.000***

						(0.000)
Constant	0.020***	0.427***	0.353***	0.375***	0.374***	0.376***
	(0.002)	(0.010)	(0.013)	(0.014)	(0.014)	(0.014)
Observations	38,059	38,059	38,059	38,059	38,059	38,059
R-squared	0.010	0.064	0.066	0.067	0.068	0.069

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
[a] Age is centered at 20.

Table 11: OLS Estimation of BMI (logged) Changes between Time t and t+1

with Interaction between Gender and Marital Transition

	Main effects	Interaction term
Marital transition (continuously married as reference)	(1)	(2)
Continuously never-married	-0.008***	-0.003
	(0.002)	(0.003)
Entry into marriage	0.014***	0.013**
	(0.005)	(0.005)
Continuously out of marriage	-0.000	-0.003
	(0.002)	(0.003)
Exit from marriage	-0.004	-0.006
	(0.003)	(0.005)
Women	0.004***	0.004***
	(0.001)	(0.001)
Continuously never-married#Women		-0.011**
		(0.004)
Entry marriage#Women		0.006
		(0.011)
Continuously out of marriage#Women		0.003
		(0.004)
Exit from marriage#Women		0.004
		(0.006)
Cons	0.376***	0.376***
	(0.014)	(0.014)
Observation	38,059	38,059
R-squared	0.068	0.069

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Both models control for age, age squared, logged BMI (T1), stature, years of schooling, employment status (T1), employment status (T1-T2), number of children (T1), number of children (T1-T2), logged income per capita (T1), logged income per capita (T1-T2), urbanization (T1) and urbanization (T1-T2).

Table 12: OLS Estimation of BMI (logged) Changes between Time t and t+1 with Interaction between Gender and Marital Transition

	(1) Main effects	(2) Interaction term
Marital transition (continuously married as reference)		
Continuously never-married	-0.008**	0.281***
	(0.004)	(0.102)
Entry into marriage	0.026***	0.261
	(0.009)	(0.205)
Continuously out of marriage	-0.004	-0.043
	(0.004)	(0.068)
Exit from marriage	-0.002	-0.007
	(0.002)	(0.047)
BMI T1	-0.143***	-0.142***
	(0.005)	(0.005)
Continuously never-married#BMI, T1		-0.095***
		(0.034)
Entry into marriage##BMI, T1		-0.077
		(0.067)
Continuously out of marriage##BMI, T1		0.003
		(0.004)
Exit from marriage##BMI, T1		0.002
		(0.015)
Cons	0.400***	0.397***
	(0.018)	(0.019)
Observation	20,660	20,660
R-squared	0.069	0.070

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Both models control for age, age squared, logged BMI (T1), stature, years of schooling, employment status (T1), employment status (T1-T2), number of children (T1), number of children (T1-T2), logged income per capita (T1), logged income per capita (T1-T2), urbanization (T1) and urbanization (T1-T2).

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CHAPTER 3

WEIGHT STATUS AND EMPLOYMENT STATUS IN CHINA

1. Introduction

China has experienced tremendous economic development since the mid-1980s. Rapid economic growth, on one hand, has successfully reduced the level of poverty and improved living standards among the Chinese population, resulting in a substantial reduction in the malnourished population (Wang, Monteiro, & Popkin, 2001, 2002). On the other hand, the prevalence of obesity has risen rapidly in tandem with the improvement of living standards and changing lifestyles (Popkin, 1999). In China, the combined prevalence of overweight and obesity increased from 14.6% to 21.8% between 1992 and 2002 (Wang, Mi, Shan, Wang, & Ge, 2006). The increasing prevalence of obesity has significant implications for health care costs: the medical costs that were attributed to overweight and obesity in China were about $2.74 billion, equivalent to 3.7% of national total medical costs, in 2003 (Zhao et al., 2008). With the alarming growth rate of obesity in China, its potential for shaping individual life chances—beyond its impact on health alone—has become an important research issue.

Extensive literature has identified detrimental effects of obesity on health worldwide. Obesity has been recognized as a key risk factor associated with morbidity and mortality (Collaboration, 2009). Given the broad recognition of the role of obesity in affecting individual health conditions, there is a growing literature that examines the implications of obesity for shaping individuals' labor market outcomes in developed countries, as health is an important form of human capital that could determine labor market outcomes (Cawdley, 2004). For example, research in the United States and the European Union suggests a wage penalty for obesity, and indicates that the magnitude of the penalty is larger for women than men (Garcia and Quintana-Domeque, 2006).

This study aims to investigate the scope of weight status-based differences in employment status, as well as possible mechanisms that account for the association between weight status and labor market outcomes, by utilizing rich information from the China Health and Nutritional Survey, a panel study in the field since 1989. Results indicate that there are employment differences associated with weight status for both Chinese women and men and that this relationship varies across level of urbanization of local communities. The gradients of employment-BMI are more sharp. Higher BMI is associated with a higher chance of being employed, but the relationships reverse after hit a tipping point of BMI. This curvilinear relationship is observed for both men and women and is more profound in highly-urbanized communities.

2. Weight Status and Labor Market Outcomes

The prevalence of obesity has been increasing rapidly in both developing and developed countries in the last several decades. Questions about the possible consequences of obesity for personal daily living and wellbeing in the era of an obesity epidemic have drawn a much attention from scholars (e.g., Averett, Sikora, &Argys, 2008; Cawly, 2004;Puhl and Brownell, 2001). One obvious question about obesity has to do with influences on an individual's health conditions. For example, research has shown that obesity is one key risk factor that triggers the onset of several chronic diseases, such as type-2 diabetes, hypertension and cardiovascular disease (WHO, 2000).

The implications of being overweight or obese are not limited to an individual's health conditions, but are also relevant in shaping other dimensions of an individual's life chances. A large body of literature has documented that obese individuals face discrimination in diverse settings, including educational institutions, the workplace, and health care institutions, as well as in forming interpersonal relationships (Puhland Brownell, 2001). Moreover, scholars have also found that those at healthy weights are more favored in marriage and labor markets (Glass, Haas, and Reither, 2010). In this study, I specifically focus on how weight status may shape an individual's labor market opportunities.

Prior research has suggested that heavier weight is related to worse labor outcomes. Obese individuals have more difficulty in finding a job, are less like to be promoted, and, on average, earn lower wages than those at healthy weights (Cawly, 2004; Han et al, 2008). Morris (2007) estimated the impact of obesity on employment status in England using longitudinal data. He found that obesity had adverse effects on employment status for both women and men. Cawley (2004) examined the effect of obesity on wages in the United States and found that there were wage penalties among white women, but not among black and Hispanic women and Hispanic men.

In recent years, several studies have examined whether there is a consistent pattern cross-nationally in the relationship between weight status and labor market outcomes. Garcia and Quintana-Domeque (2006) examined weight status-related differences in wages and employment status using the European Community Household Panel Survey and found that the wage penalties for women for being obese varied from 2 to 10 percent, and the penalty was much smaller for men than for women. The authors argue that countries with stronger unions may have weaker wage penalties based on weight status than countries with weaker unions. Additionally, the responsibility of employers to provide health insurance may be another factor that triggers penalties against workers with heavier weight, if, as is the case in the United States, employers may expect to pay higher costs for the health insurance of obese workers (Bhattacharya and Bundorf, 2009). In sum, weight-related disparities in wages and employment might vary by country because of different labor market conditions (Garcia and Quintana-Domeque, 2006).

The labor market conditions are much more stable, mature and regulated in developed than in developing countries, and thus whether findings from existing literature about the relationships between employment status and physical appearance carry implications for developing countries is unclear. China is a significant and interesting case for testing the relationship between employment status and BMI due to its status as a rapidly developing economy. China is also characterized by a vast volume of rural-to-urban migration and rapid urbanization--trends pronounced in China but common in developing countries.

3. Mechanisms

There are at least two possible channels that explain the association between weight status and labor market outcomes. First, weight status may affect labor market outcomes through health conditions. As noted earlier, obesity is a key risk factor that increases the risk of morbidity and mortality. If health is considered as an important form of human capital, then an unhealthy weight is expected to lower an individual's productivity in labor market. Empirical evidence in the U.S has shown that obesity is associated with absenteeism. Tucker and Friedman (1998) have examined the association between weight status and absences from work due to illness using cross-sectional data. They found that obese employees were about 1.6 times more likely to experience high and moderate levels of absences due to illness, compared to their lean counterparts .Finkelstein, Fiebelkorn, and Wang (2005) also found that obese status is related to more than a 50% increase in missed days due to illness or injury for full-time employed men and women. Employers might be reluctant to hire heavier employees due to concerns about productivity and potential costs of health insurance.

Weight-base discrimination is another possible channel that explains why obese individuals are disadvantage in labor market. According to Roehling's (1999) review of weight-based discrimination in the labor market, there is evidence for discrimination against overweight individuals at every stage of the employment process from hiring decisions, to job placements, to decisions about promotion. In addition, obese individuals are reportedly more likely to be perceived as lazy and lacking in self-control by their coworkers and employers (Rudolph, Wells, Weller, & Baltes, 2009). These negative attitudes toward obese people in the workplace may affect their chances of being hired or their performance, net of their actual ability.

4. Research Questions

In this study, I aim to answer four research questions (1) What is the association between weight status and employment status in China? (2) Is there a gender difference in the linkage between weight status and employment status? (3) What possible mechanisms mediate the observed associations? (4) Does the relationship between BMI and employment status varies across different regions?

5. China Context

Economic development in the last three decades in China successfully reduced the overall level of poverty, resulting in a declining prevalence of malnutrition (Wang, Monteiro, & Popkin, 2002). Although malnutrition remains a concern in remote areas, over-nutrition has now emerged as a major health concern. There is an emerging body of literature that investigates the determinants and health consequences of obesity (Wang, Mi, Shan, Wang, & Ge, 2006; Popkin, 2001). However, how body weight shapes an individual's labor market opportunity is not yet clear.

Body weight is commonly perceived as a proxy for health or physical appearance ,both of which are recognized as important forms of human capital. Human capital may have been only weakly related to labor market outcomes in the socialist period in China before 1980. However, returns to human capital rose very fast after the transition from socialism to a market economy in the 1980s (J. Zhang, Zhao, Park, & Song, 2005). In a market economy, those who possess more human capital receive higher economic rewards in market than in socialism economy (Cao & Nee, 2005). Researchers have examined several individual characteristics that possibly affect personal economic opportunities and rewards in the labor market, including education, gender, marriage and parenthood (Cao & Nee, 2005;Zhang, Hannum, & Wang, 2008).

To date, it is rare to find research that examines the association between weight status and labor market opportunities. One exception is Luo & Zhang (2012), who explored whether there is a weight penalty in wages and employment status using a cross-sectional design. The authors found that heavier men and women earn lower wages and are less likely to be employed than those at a healthy weight. One disadvantage of their study is that they use self-reported BMI. Evidence from the United States suggests that men tend to over-report their height and women tend to under-report their weight, resulting under-estimated BMI (Nyholm et al., 2007).

Another feature of labor markets in China is highly-imbalanced regional economic development and this imbalanced economic regional development has generated distinct variations of labor market structures across China. Labor markets in highly-urbanized regions, on one hand, have a high proportion of laborers in service industries in which physical appearance is more likely to be a concern for employers during the hiring process. On the other hand, labor markets in highly-urbanized regions are highly competitive because of the vast numbers of rural to urban migrants. In highly competitive labor markets, physical appearance, including height and weight, may be perceived by both employers and employees as an index of productivity. Media reports suggest that certain employees take extreme measures to change their appearance, including leg-lengthening surgery, in order to make them competitive in the labor markets (Watts, 2004). Moreover, unlike the case of the US or European countries, there is lack of anti-discrimination laws in China (Yuwen & Goldschmidt, 2009), and thus physical appearance discrimination in labor markets in China can be overt. Height, weight and physical appearance requirements are commonly seen and explicitly stated in job advertisements (Kuhn & Shen, 2009; Lu, 2009). The discrimination based on physical appearance is likely to be intensified in highly-competitive and service-oriented labor markets.

6. Data and Methods

The China Health and Nutrition Survey (CHNS) is a panel survey ongoing since 1989 in 9 provinces of China (one province was added in since 1997). There are approximately 4000 households and 15,000 individuals in the survey. This survey not only followed household members who currently live in the household, but also household members who formed new households in the same communities. This data has been utilized to examine socioeconomic change, family dynamics, and health and nutrition issues in China.

Due to availability of variables of interest for this analysis, I employ data from the 1991,1993,1997,2000, 2004, 2006 and 2009 rounds of the China Health and Nutritional Survey. The target population of my analysis is those ages 18 and above. I limit respondents to those within these age ranges between 1991 and 2009. There are 58,084 person-time observations. Approximately98% of individuals have at least two observations. For time-invariant variables such as education and stature, I used maximum values of these variables for each individual during the observed period to reduce missing values. Then, I excluded sample elements with missing or inconsistent numbers for both weight status and employment status, and other independent variables. With these exclusion criteria, about 17% of person-time observations were excluded. I also excluded pregnant women, who accounted for around 3,200 person-time observations. The final analytical sample is 48,468 person-time observations.

6.1 Dependent Variables

Employed. The dependent variable is employment status. Self-employed, long-term and temporary work and is coded as 1 if yes. The reference group includes both unemployed and not in the labor force and is coded as 0.

6.2 Main Explanatory Variables

I use both *weight status* and *stature* to measure physical appearance. *Weight status* is a time-varying variable in this study. *Weight status* is measured by BMI. BMI is defined as weight (kg) divided by height (m) squared. Because prior research has suggested that the relation between BMI and wage or employment status is nonlinear (Luo & Zhang, 2012), I also include *BMI squared* in the models. Table 2 presents the distribution of weight status over survey years by gender. As can be seen, the prevalence of overweight and obesity has risen rapidly for both men and women between 1991 and 2009.

[Table 1 about here.]

Table 1 shows a description of all variables used in the analysis. *Stature* is another important element of physical appearance that may affect an individual's labor market opportunities (Behrman, 2009; Persico, Postlewaite, and Silverman, 2004), especially height requirement is not uncommon being stated explicitly in job advertisement (Yuwen & Goldschmidt, 2009), therefore, I also include *stature* as a control variable. *Stature* is coded as a continuous variable and the unit is 10cm. *Stature squared* is also included to test the possibility of a non-linear relationship between employment status and stature. Although there could be concern that there is a high correlation between BMI and stature by definition, people with the same BMI may have different statures, and vice versa. Thus, I include these two correlated but distinct variables in the analysis at the same time.

[Table 2 about here.]

6.3 Mediator variables

Schooling years. Education is a key element of human capital, which is associated with both employment status and BMI. For both men and women, higher education is associated with better labor market opportunities, however, the association between education and BMI is different between men and women. Better-educated men, on average, have heavier weight in China. In contrast, better-educated women on average have lower BMI than their less-educated counterparts (McLaren, 2007). *Schooling years* is treated as a continuous variable.

One possible mechanism that explains the linkage between employment status, BMI and stature is health condition. To at least partially account for this mechanism, I include whether respondents have *diagnosed hypertension*. *Diagnosed hypertension* is coded as 1 if yes and 0 otherwise.

I also include both whether respondents are current drinkers and smokers. *Current drinker* is coded as 1and 0 otherwise and *current smoker* is coded in the same way. Both drinking and smoking are related to weight status. Quitting smoking is associated with weight loss and drinking alcohol is associated with weight gain.

Meanwhile, there is a high prevalence of drinking and smoking in business or social occasions. Social drinking, smoking and eating play important roles in building and maintaining *Guanxi* (social networks) and are also important in wide range of social settings (Bian, 2001; Bian & Ang, 1997).

Marital status. In the original questionnaires, *marital status* contains five categories: never married, married, divorced, separated and widowed. As the number of cases of separated is small, I grouped divorced and separated as one category. I then constructed a set of dummy variables. Married is the reference group in all analyses.

Number of children. This variable may be relevant in understanding the relation between BMI and labor employment status, especially for women. Women who have ever had a child are more likely to have heavier weight than those who never did and are also more likely to leave work in order to take care of children. This variable is constructed as a set of dummy variables. Three children and above are grouped into a single category. Missing values for number of children are coded as a dummy variable that is included in the models.

Urbanization. There is huge regional variation in urbanization and socioeconomic development in China. Much prior research examines the social inequality across regions by using a dichotomous variable--rural versus urban--to capture regional variation in socioeconomic development. This study utilizes an index of urbanization, which reflects overall economic development, education, sanitation, and transportation at the community level (for details, see Jones-Smith & Popkin, 2010). Prior research in China has suggested that level of urbanization is a strong predictor of individual BMI (Monda, Gordon-Larsen, Stevens, & Popkin, 2007; Popkin, 1999) . Meanwhile, labor market structures also vary across different levels of urbanization. There are more diverse and service-oriented job opportunities in highly-urbanized regions.

Year dummies .China has experienced rapid economic growth, and, at the same time, the Chinese population has become much heavier in recent decades. Therefore, survey year dummies are included in all models to account for period effects that are associated with both BMI and employment opportunities.

6.4 Methods

All analyses are estimated by random- and fixed- effects models. Random-effects models allow examination of the relationship between time-invariant variables and outcome variables. Individual fixed-effects can take into account time-variant omitted variables.

7. Results

Table 3 presents odds ratios from bivariate binary logistic regressions of employment by gender. First, there is curvilinear relationship between employment and BMI. Higher BMI is associated with better job opportunities, but the relationship is reversed after reaching a certain level of BMI. For health, having diagnosed hypertension is related to lower odds of being employed for men, but higher odds of being employed for women. Further, the relationships between employment status, health behaviors and number of children differ by gender. Being a current drinker and smoker are associated with higher odds of being employed for men, but lower odds of being employed for women. There is also a gender difference in the relationship between employment status and number of children. Women are more likely to drop out of labor markets because of having children (Y. Zhang, Hannum, & Wang, 2008).These bivariate associations display that there are gender differences in job prospects related to health, health behaviors and number of children.

[Table 3 about here.]

[Table 4 about here.]

Table 4 examines the relationship between employment status and BMI for men. Model (1) displays a curvilinear relationship between employment status with BMI and BMI squared, controlling for stature, age, age squared, urbanization and survey dummies. Results show that there is no relationship between employment and weight status if the variability of the relationship between employment status and BMI across the level of urbanization of local communities is not taken into account.

In model (2), interaction terms between BMI, BMI squared and urbanization are added to test whether and how the relationship between BMI and employment status varies across communities with different levels of urbanization. The interaction term between BMI and urbanization and the interaction term between BMI squared and urbanization are both statistically significant at $p<0.01$, suggesting that the relationship between employment status and BMI depends on the level of urbanization of local communities. In model (3), schooling years is added in the model. Schooling years is a potential confounder that is positively associated with BMI among men and with labor market opportunities in China. The curvilinear association between BMI and employment is partly explained by schooling years, but the relationship remains robust. Although schooling years has been shown to be an important confounder that is related to the both higher chance of being employed and higher BMI for men, the curvilinear relationship between BMI and employment status persists.

In model (4), I further control for having diagnosed hypertension, drinking and smoking to test whether health conditions and behaviors account for the BMI-employment relationship. As expected, diagnosed hypertension is associated with lower odds of being employed. Drinking and smoking are both related to higher odds of being employed among men. These positive relationships are consistent with business culture and social customs in which both drinking and smoking play important roles in building Guanxi (networking) in business, at formal or informal occasions. Nonetheless, the relationship between BMI and employment is persistent, suggesting that health conditions and behaviors don't explain the observed BMI-employment relationship.

Family factors, namely marital status, number of children and household income per capita, are further added in model (5). For marital status, only never-married is associated with lower odds of being employed, relative to married. Number of children is not related to employment status, reflecting the fact that wives or grandparents are often responsible for taking care of children in Chinese contexts (Chen & Liu, 2012). In model (6), an individual fixed-effects approach is applied to control unobserved heterogeneity. This curvilinear relationship between employment status and BMI persists and varies across level of urbanization. The curvilinear relationship between employment status and BMI is more profound in highly-urbanized communities. Higher BMI is associated with a better chance of being employed, but the chance of being employed goes down after BMI hit a tipping point.

Overall, there is curvilinear relationship between employment status and the relationship between employment status depends on the level of urbanization. Increasing BMI is positively related with employment status at the beginning and then the relationship turns negative, as the BMI reaches certain level. This pattern is more pronounced in highly urbanized communities.

[Table 5 about here.]

I repeated the same analysis with a female subsample. The results are displayed in Table (5). Although there is a curvilinear relationship between employment status and BMI in bivariate analysis, as shown in the Table 3, the relationship between employment status and BMI for women is not statistical significant after adjusting for demographic variables, stature, urbanization and survey dummies in model (1). The relationship only emerges in fixed-effects estimations (Model 6).The relationship between employment and BMI is also curvilinear and depends on the level of urbanization of local communities. Moreover, there is a negative relationship between employment status and having two children, relative to no children, among women in China. This pattern is contrary to the men's pattern and is consistent with prior research that there is a motherhood penalty in China (Y. Zhang, Hannum, & Wang, 2008).

7.1 Summary and Conclusions

In summary, there are BMI-weight gradients for both men and women and the relationship depends on the level of urbanization of communities. These findings, on one hand, are consistent with prior research that there are weight penalties in labor markets for women in some western developed countries. However, research in most western developed countries finds weak to non-existent BMI-employment relationships for men, but not in China. Possible explanations for the existence of BMI-employment gradients for both men and women is weak unions in labor markets in China and lack of anti-discrimination laws. As suggested by Garcia and Quintana-Domeque (2006), weight-discrimination in labor markets is likely to emerge in countries with weak unions. There is no information about union participation or the execution of anti-discrimination in this dataset, thus I am not able to test this hypothesis.

In addition, the observed BMI and employment relationship is not explained by health conditions, health behaviors or family-related factors. Even though the results show that having hypertension is related to lower odds of being employed, hypertension explains little about the BMI and employment status relationship. The weight discrimination in the U.S. is partly explained by health conditions because healthcare cost of employees is covered by employers (Bhattacharya and Bundorf, 2009). While the responsibility of employers covering health insurance of employees is relatively low, thus having hypertension does not explain the relationship between BMI and employment status. It is possible that productivity of heavier employees is a more major concern than cost of health insurance for employers in China.

Furthermore, we see that the relationship between BMI and employment depends on the level of urbanization of local communities. The gradient is more obvious in more-urbanized than in less-urbanized communities. Labor markets and economic development vary substantially across different regions. In other words, weight-based discrimination in terms of labor market outcomes may be exacerbated in more urbanized, competitive regions in China.

8. Tables and Figures

Table 13: Description of All variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Employed	57707	0.71	0.45	0	1
BMI	51592	22.72	3.27	12.42	43.37
Stature	56769	161.66	8.36	83.7	189.50
Age (centered at 41)	57883	5.53	15.48	-23	59.83
Age squared	57883	2.70	3.76	0	35.80
Schooling years	57551	7.63	4.17	0	18
Diagnosed hypertension	54594	0.08	0.27	0	1
Current drink	56025	0.35	0.48	0	1
Current smoking	55958	0.30	0.46	0	1
Marital Status (married as reference)	57498				
Never married		8.12			
Divorced/separated		1.08			
Widowed		6.93			
Number of child	58084				
1		24			
2		21.37			
3		21.9			
Missing		21.71			
Household income per capita	57379	9.52	1.04	1.07	13.66
Urbanization	58084	57.70	20.39	16.73	106.58
Survey year					
1991	8523				
1993	7115				
1997	8176				
2000	8657				
2004	8288				
2006	8464				
2009	8861				

Table 14: Distribution of Weight status by Gender (%), CHNS 1991-2009

	Underweight (BMI<18.5)	Normal (BMI:18.5~22.9)	Overweight (BMI: 23~27.4)	Obesity (BMI>=27.5)	Person-time observations
			Men		
1991	9.68	67.18	20.53	2.6	3,419
1993	7.8	65.82	23.62	2.75	2,870
1997	7.14	57.95	28.81	6.09	3,332
2000	5.79	50.35	35.71	8.15	3,400
2004	5.32	46.66	38.3	9.72	3,590
2006	5.64	44.9	39.51	9.95	3,597
2009	5.65	41.45	41.94	10.96	3,858
			Women		
1991	10.02	60.12	25.95	3.9	3,842
1993	9.79	58.66	27.42	4.13	3,198
1997	7.81	52.45	32.04	7.7	3,586
2000	7.19	46.03	36.42	10.35	3,921
2004	6.47	45.09	37.15	11.28	4,156
2006	5.68	44.52	37.95	11.85	4,277
2009	6.56	42.5	38.67	12.28	4,544

Table 15: Odds Ratios from Bivariate Binary Logistic Regression of Being Employed on Independent Variables by Gender

	(1) Men		(2) Women	
BMI	1.281***	(0.067)	1.205***	(0.048)
BMI squared	0.521***	(0.056)	0.556***	(0.046)
Stature	1.012***	(0.003)	1.013***	(0.002)
Age (centered at 41)	0.972***	(0.002)	0.953***	(0.001)
Age squared	0.744***	(0.006)	0.838***	(0.006)
Schooling years	1.044***	(0.005)	1.071***	(0.003)
Hypertension	0.223***	(0.011)	1.440***	(0.065)
Current drinker	2.088***	(0.068)	0.202***	(0.010)
Current smoker	2.164***	(0.070)	0.437***	(0.028)
Marital status (married as reference)				
Never-married	0.913	(0.054)	1.697***	(0.115)
Divorced/separated	0.714**	(0.099)	0.686***	(0.093)
Widowed	0.248***	(0.019)	0.189***	(0.009)
Number of child (0 as reference)				
1	1.485***	(0.097)	0.681***	(0.042)
2	1.441***	(0.096)	0.630***	(0.039)
3	1.380***	(0.091)	0.726***	(0.045)
Missing+	0.228***	(0.013)	0.089***	(0.006)
Household income per capita	1.044***	(0.016)	1.034***	(0.013)
Constant	0.396	(0.244)	0.475*	(0.199)
Person-time observations	22,573		25,895	

Table 16: Random- and Fixed- Effects Logistic Regressions of Being Employed with BMI and Interaction between BMI and Urbanization among Chinese Men aged 18 and above

	(1)	(2)	(3)	(4)	(5)	(6)
BMI	0.974	0.228***	0.231***	0.228***	0.319***	0.231*
	(0.107)	(0.094)	(0.095)	(0.094)	(0.130)	(0.174)
BMI squared	0.993	13.349***	12.942***	13.693***	6.796**	18.275*
	(0.227)	(11.610)	(11.210)	(11.875)	(5.831)	(30.387)
BMI#urbanization		1.024***	1.023***	1.023***	1.018***	1.029***
		(0.006)	(0.006)	(0.006)	(0.006)	(0.010)
BMI squared#urbanization		0.959***	0.959***	0.959***	0.970**	0.946**
		(0.012)	(0.012)	(0.012)	(0.012)	(0.021)
Stature	0.783	1.278	1.276	1.315	1.507	
	(0.171)	(1.030)	(1.032)	(1.044)	(1.109)	
Stature#urbanization		0.997	0.997	0.997	0.994	0.988
		(0.011)	(0.011)	(0.011)	(0.010)	(0.023)
Stature squared	1.074	0.897	0.897	0.891	0.854	
	(0.070)	(0.215)	(0.216)	(0.211)	(0.188)	
Stature squared#urbanization		1.001	1.001	1.001	1.002	1.004
		(0.003)	(0.003)	(0.003)	(0.003)	(0.007)
Urbanization	0.947***	0.759	0.775	0.785	1.042	2.102
	(0.002)	(0.730)	(0.746)	(0.743)	(0.920)	(4.095)
Age (centered at 41)	0.982***	0.980***	0.983***	0.982***	0.951***	0.680
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.332)
Age squared	0.582***	0.580***	0.583***	0.600***	0.686***	0.645***
	(0.011)	(0.011)	(0.011)	(0.012)	(0.015)	(0.031)
Schooling years			1.035***	1.039***	1.010	
			(0.013)	(0.013)	(0.012)	
Diagnosed hypertension				0.653***	0.641***	0.699**
				(0.069)	(0.067)	(0.106)
Current drinker				1.616***	1.483***	1.181*
				(0.105)	(0.097)	(0.105)
Current smoker				1.332***	1.315***	1.188*
				(0.090)	(0.090)	(0.124)
Marital status (currently married as reference)						
Never-married					0.125***	0.235***
					(0.032)	(0.106)
Divorced/separated					1.147	1.259
					(0.316)	(0.616)
Widowed					1.550**	1.585

					(0.299)	(0.665)
Number of children (0 as reference)						
1					1.011	0.892
					(0.234)	(0.341)
2					0.811	1.046
					(0.194)	(0.529)
3+					0.852	1.255
					(0.209)	(0.694)
Missing					0.517***	0.811
					(0.124)	(0.378)
Household income per capita					1.723***	1.630***
					(0.063)	(0.086)
Survey dummies	Yes	Yes	Yes	Yes	Yes	Yes
Model	RE	RE	RE	RE	RE	FE
Person-time observations	22,573	22,573	22,573	22,573	22,573	7,033
N	7,735	7,735	7,735	7,735	7,735	1,670

***,**,* denotes significant level at 1%, 5%, and10% respectively

[a] RE represents random-fixed effects model; [b] IFE represents individual-fixed effects model.

All models include survey year dummies and province dummies

Table 17: Random- and Fixed- Effects for Logistic Regression of Being Employed with BMI and Interaction between BMI and Urbanization among Chinese Women aged 18 and above

	(1)	(2)	(3)	(4)	(5)	(6)
BMI	1.010	0.848	0.867	0.854	0.929	2.791***
	(0.075)	(0.217)	(0.220)	(0.215)	(0.230)	(1.111)
BMI squared	0.817	1.338	1.276	1.315	1.100	0.110***
	(0.125)	(0.718)	(0.678)	(0.692)	(0.570)	(0.091)
BMI#urbanization		1.003	1.003	1.002	1.001	0.986**
		(0.004)	(0.004)	(0.004)	(0.004)	(0.006)
BMI squared#urbanization		0.992	0.993	0.993	0.997	1.032***
		(0.008)	(0.008)	(0.008)	(0.008)	(0.012)
Stature	0.748	2.032	2.104	2.197	2.395	
	(0.140)	(1.219)	(1.257)	(1.284)	(1.365)	
Stature#urbanization		0.990	0.988	0.988	0.986	0.965*
		(0.009)	(0.009)	(0.009)	(0.009)	(0.020)
Stature squared	1.089	0.757	0.748	0.739	0.721*	
	(0.065)	(0.145)	(0.143)	(0.138)	(0.132)	
Stature squared#urbanization		1.004	1.004	1.004	1.005*	1.011*
		(0.003)	(0.003)	(0.003)	(0.003)	(0.007)
Urbanization	0.958***	1.778	1.947	1.986	2.462	19.949*
	(0.002)	(1.341)	(1.459)	(1.460)	(1.787)	(31.627)
Age (centered at 41)	0.950***	0.950***	0.957***	0.959***	0.963***	0.653
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.280)
Age squared	0.699***	0.700***	0.704***	0.709***	0.762***	0.726***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.014)	(0.022)
Schooling years			1.057***	1.054***	1.044***	
			(0.010)	(0.010)	(0.010)	
Diagnosed hypertension				0.686***	0.709***	0.967
				(0.064)	(0.067)	(0.124)
Current drinker				1.595***	1.575***	1.204*
				(0.123)	(0.122)	(0.136)
Current smoker				0.529***	0.581***	1.051
				(0.068)	(0.076)	(0.225)
Marital status (currently married as reference)						
Never-married					0.260***	0.253**
					(0.055)	(0.150)
Divorced/separated					1.245	0.508
					(0.303)	(0.249)
Widowed					1.076	1.330

					(0.122)	(0.270)
Number of children (0 as reference)						
1					0.646**	0.541
					(0.115)	(0.213)
2					0.427***	0.333**
					(0.079)	(0.164)
3+					0.547***	0.479
					(0.105)	(0.290)
Missing					0.202***	0.477
					(0.040)	(0.397)
Household income per capita					1.409***	1.340***
					(0.037)	(0.044)
Survey dummies	Yes	Yes	Yes	Yes	Yes	Yes
Model	RE	RE	RE	RE	RE	FE
Person-time observations	25,895	25,895	25,895	25,895	25,895	11,174
N	8,847	8,847	8,847	8,847	8,847	2,568

***,**,* denotes significant level at 1%, 5%, and10% respectively

[a] RE represents random-fixed effects model; [b] IFE represents individual-fixed effects model.

All models include survey year dummies and province dummies.

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APPENDIX

Bivariate coefficients between attrition status and all variables used in the analysis with binary logistic estimation is presented in Appendix A. Attrition is defined as not followed up in every subsequent wave of the survey. If the respondent participates every of the survey is coded as 0 and 1 otherwise. Results show that poor health, women, lower educated, employed, family with higher household income per capita and living in lower urbanized community, are associated with lower log odds of attrition than excellent health, men, higher educated, unemployed, family with lower household income per capita and living in more urbanized community. With regards to marital status, being single is associated with higher log odds of attrition relative to their married counterparts. Divorced is associated with lower log odds of attrition, relative to married. There is no difference in attrition status between married and widow.

As presented in Appendix A, the relations between attrition status and each variable have indentified, the next step is to test whether the estimations in this study is biased because of sample attrition. Appendix B presents the examination of whether attrition biased estimations presented in the study. For model (1), it is the identical model with model (4) in Table 6, testing three-way interaction between gender, marital status and age with linear random-effects models. Model (2) includes attrition status dummy and interaction terms between attrition status and all other independent variables in the model (1). Most of the interaction terms in model (2) are not statistically significant from 0, except gender, age squared term, three-way interaction of gender, divorced and age, and highest level of education. Model (4) tests the interaction term between attrition status and each independent variables with fixed-effects models. Interactions between attrition status and age, age squared term are statistically significant at $p<0.01$ level, and are likely to be results of migration and mortality. Although the coefficient of three-way interaction between gender, divorced and age is slightly biased, other coefficients of main interests in this study, such as marital status, and interaction between gender, marital status and age are not biased due to sample attrition.

Appendix A: Bivariate Coefficients From Binary Logistic Estimations of Attrition Status with All Variables in the Analysis

	Coefficients	Standard Error
Self-rated health (excellent as reference)		
Very poor	-0.051	(0.057)
Poor	-0.205***	(0.036)
Good	-0.046	(0.031)
Female	-0.180***	(0.038)
Current marital status (married as reference)		
Single	1.702***	(0.182)
Divorced	-0.567***	(0.154)
Widow	-0.063	(0.165)
Age	-0.146***	(0.005)
Age squared	0.198 ***	(0.007)
Stature (cm)	0.003	(0.002)
Highest level of education (primary school and below as reference)		
Upper middle or vocational school	0.231***	(0.044)
College and above	0.385***	(0.048)
Employed	-0.235***	(0.031)
Household income per capita (logged)	-0.081***	(0.013)
Urbanization	0.007***	(0.001)
Province (Liaoning as reference)		
Heilongjiang	-0.583***	(0.080)
Jiangsu	-0.210***	(0.079)
Shandong	0.087	(0.083)
Henan	0.045	(0.081)
Hubei	-0.109	(0.082)
Hunan	-0.087	(0.083)
Guangxi	0.019	(0.081)
Guizhou	-0.044	(0.080)

Appendix B: Comparison of Results between Sample with Attrition and No-attrition

	(1)	(2)	(3)	(4)
Female	-0.076***	-0.112***		
	(0.011)	(0.018)		
Single	-0.065**	-0.142**	0.041	0.003
	(0.025)	(0.069)	(0.047)	(0.091)
Female*single	0.032	0.041	-0.076	-0.061
	(0.035)	(0.174)	(0.092)	(0.197)
Single*age	0.001	0.004	0.001	0.007
	(0.002)	(0.004)	(0.003)	(0.007)
Female*single*age	-0.001	-0.010	0.003	0.013
	(0.004)	(0.013)	(0.006)	(0.012)
Divorced	-0.171	-0.245	-0.057	-0.073
	(0.111)	(0.238)	(0.167)	(0.304)
Female*Divorced	0.007	0.277	-0.123	0.174
	(0.154)	(0.286)	(0.228)	(0.393)
Divorced*age	0.004	0.010*	0.003	0.011
	(0.003)	(0.006)	(0.005)	(0.008)
Female*divorced*age	-0.000	-0.016**	0.001	-0.017
	(0.004)	(0.008)	(0.007)	(0.011)
Widow	-0.115	-0.217	0.141	0.125
	(0.131)	(0.204)	(0.185)	(0.276)
Female*widow	-0.332**	-0.220	-0.520**	-0.689**
	(0.149)	(0.242)	(0.220)	(0.332)
Widow*age	0.003	0.006	-0.001	0.001
	(0.003)	(0.004)	(0.004)	(0.005)
Female*widow*age	0.006**	0.004	0.009**	0.011*
	(0.003)	(0.005)	(0.004)	(0.007)
Age	-0.014***	-0.012***	-0.005**	-0.013***
	(0.001)	(0.002)	(0.002)	(0.003)
Age squared	-0.002	-0.008**	-0.035***	-0.026***
	(0.002)	(0.003)	(0.003)	(0.005)
Stature (cm)	0.001	0.000		
	(0.001)	(0.001)		
Highest level of education (primary school and below as reference)				
Upper middle or vocational school	0.050***	0.015		
	(0.010)	(0.016)		
College and above	0.090***	0.047**		
	(0.011)	(0.020)		
Employed	0.076***	0.075***	0.037***	0.043**
	(0.009)	(0.015)	(0.011)	(0.018)
Household income per capita (logged)	0.020***	0.018***	0.020***	0.018***
	(0.004)	(0.006)	(0.005)	(0.007)

Urbanization	-0.000	-0.000	0.002***	0.002**
	(0.000)	(0.000)	(0.001)	(0.001)
Attrition		-0.334		
		(0.252)		
Gender*attr		0.052**		
		(0.023)		
Single *attr		0.102		0.080
		(0.075)		(0.106)
Female*single*attr		-0.027		-0.026
		(0.177)		(0.222)
Single*age*attr		-0.005		-0.009
		(0.004)		(0.008)
Female*single*age*attr		0.012		-0.012
		(0.013)		(0.013)
Divorced*attr		0.130		0.051
		(0.269)		(0.359)
Female*Divorced*attr		-0.335		-0.370
		(0.341)		(0.485)
Divorced*age*attr		-0.011		-0.013
		(0.007)		(0.010)
Female*divorced*age*attr		0.020**		0.025*
		(0.009)		(0.014)
Widow*attr		0.162		0.045
		(0.266)		(0.366)
Female*widow*attr		-0.141		0.250
		(0.309)		(0.439)
Widow*age*attr		-0.004		-0.003
		(0.005)		(0.007)
Female*widow*age*attr		0.002		-0.002
		(0.006)		(0.009)
Age*attr		-0.002		0.013***
		(0.003)		(0.005)
Age squared*attr		0.000**		-0.000**
		(0.000)		(0.000)
Stature (cm)*attr		0.001		
		(0.001)		
Highest level of education (primary school and below as reference)				
Upper middle or vocational school*attr		0.055***		
		(0.020)		
College and above*attr		0.062***		
		(0.024)		
Employed*attr		0.000		-0.010
		(0.019)		(0.023)
Household income per capita (logged) *attr		0.004		0.005

		(0.008)		(0.009)
Urbanization*attr		0.000		-0.001
		(0.000)		(0.001)
Model	RE	RE	FE	FE
Observations	53,404	53,404	49,292	49,292
Number of id	17,378	17,378	13,266	13,266

All models includes dummies of provinces and interaction terms between provinces and attrition status
***,**,* denotes significant level at 1%, 5%, and 10% respectively.
Robust standard error is presented in the parenthesis
[a]OLS represents ordinary least square regression; [b] RE represents random-fixed effects model; [c] FE represents fixed-effects model.

Appendix C: Auxiliary analysis of Current Smoke Status with Marital Status among Chinese Men with Random- and Fixed-effects Models

	(1)	(2)	(3)	(4)
Currently married (married as reference)				
Single	-0.633***	-1.087***	-0.232	-0.888***
	(0.117)	(0.176)	(0.157)	(0.247)
Single*age		0.037***		0.068***
		(0.010)		(0.020)
Divorced	-0.167	-0.094	0.143	0.872
	(0.232)	(0.573)	(0.281)	(0.649)
Divorced*age		-0.002		-0.022
		(0.017)		(0.020)
Widow	-0.038	-0.368	-0.255	-0.306
	(0.157)	(0.597)	(0.237)	(0.852)
Widow*age		0.007		0.001
		(0.012)		(0.017)
Age	0.091***	0.079***	0.036***	0.019
	(0.010)	(0.010)	(0.014)	(0.015)
Age squared	-0.175***	-0.162***	-0.198***	-0.176***
	(0.014)	(0.015)	(0.020)	(0.021)
Stature (cm)	0.009	0.010		
	(0.006)	(0.006)		
Highest level of education (primary school and below as reference)				
Upper middle or vocational school	-0.150*	-0.155*		
	(0.090)	(0.090)		
College and above	-0.470***	-0.477***		
	(0.100)	(0.100)		
Employed	0.378***	0.372***	0.203***	0.209***
	(0.067)	(0.067)	(0.079)	(0.079)
Household income per capita (logged)	-0.113***	-0.109***	-0.024	-0.020
	(0.026)	(0.026)	(0.031)	(0.031)
Urbanization	-0.013***	-0.013***	0.004	0.004
	(0.002)	(0.002)	(0.004)	(0.004)
Constant	0.287	0.398		
	(1.082)	(1.088)		
Model	RE	RE	FE	FE
Person-times observations	25,475	25,475	10,018	10,018
N	8,142	8,142	2,434	2,434

All models includes dummies of provinces.
***,**,* denotes significant level at 1%, 5%, and 10% respectively.

Robust standard error is presented in the parenthesis
[a]OLS represents ordinary least square regression; [b] RE represents random-fixed effects model; [c] FE represents fixed-effects model.